RECORDS

OF THE

AUSTRALIAN MUSEUM

VOL. XXIV

PRINTED BY ORDER OF THE TRUSTEES

Edited by the Director, J. W. Evans, Sc.D.

SYDNEY, 1956-1959

* 65689—1

CONTENTS

LIST OF CONTRIBUTORS

ADDITIONS TO THE AUSTRALIAN FRESHWATER CRAYFISH

By E. F. Riek

Commonwealth Scientific and Industrial Research Organisation—Division of Entomology, Canberra, A.C.T.

Plate 1.

Since the author's paper (1951),* dealing mainly with Queensland freshwater crayfish, much additional material has been examined. New species are described in the present paper and additional information is given on some other species.

Three new species of *Euastacus* and one of *Cherax* are described from the highlands of eastern New South Wales. A new genus, *Euastacoides*, is erected for three new species from south-east Queensland. Specimens of this new genus are in many ways similar to juvenile *Euastacus* but they lack the characteristic spines of that genus and though of relatively small size are mature as is evidenced by the width of the abdomen in females and the ejection of spermatophores by some males when preserved.

Euastacus cunninghami Riek.

Euastacus cunninghami Riek 1951, Rec. Aust. Mus. XXII:379.

A series of eight specimens was collected at the headwaters of a small creek where it entered the rain-forest at Tarome, Queensland. The specimens range in size up to 120 mm and the largest, a female, is ovigerous (collected 12 October 1953). A colour description of the series is given.

Colour.—Body dark, with reddish hues especially on the branchiostegites; meson of abdomen whitish, particularly on somites 2, 3 and 4; spines and bosses of abdomen white; venter of cephalothorax pale, flesh-coloured with yellowish-red hues, venter of abdomen bluish water-white, venter of antenna red; great chelae coloured as cephalothorax, claws bluish-grey, joints reddish, chelae rather dark below, palm mostly dull-reddish but dark at upper caudal half.

Euastacus valentulus Riek.

Euastacus valentulus Riek 1951, Rec. Aust. Mus. XXII:380.

A series of eleven specimens ranging in size from 50 mm to 130 mm was collected at the type locality. Ten of the series are juvenile ranging in size up to 90 mm. The largest specimen is an ovigerous female (here designated as allotype).

The rostral carinae usually bear four spines, sometimes only three. On the upper part of the branchiostegites there are a number of enlarged, flattened, black tubercles (very obvious even in the smallest specimens). The sixth abdominal somite is without spines.

Colour.—Body all dark above; green-black on chelae and legs, also pleura, telson and uropods; dorsal cephalothorax blackish, dorsal abdomen brownish; chelae below, particularly propodus and dactylus, bright-blue; ventral cephalothorax and bases of legs water-whitish with red hues; joints of legs red; upper, enlarged tubercles of branchiostegites black, lower smaller tubercles all white; ventral spines of chelae white.

Types.—Holotype male and paratype male were deposited in the Queensland Museum (presumed lost). Allotype female (here designated) in the Australian Museum.

Specimens Examined.—Upper reaches of Currumbin Creek, Queensland (1 October 1953, E. F. Riek), a series of eleven specimens, deposited in the Australian Museum, Sydney.

Euastacus hystricosus Riek.

Euastacus hystricosus Riek 1951, Rec. Aust. Mus. XXII:380.

A series of six specimens ranging in size up to 150 mm from Elaman Creek, Maleny, Queensland. The largest specimen is an ovigerous female.

The types appear to have been gerontic specimens. In the series from Maleny there are generally four spines on each rostral carina, the branchiostegite bears an irregular zone of enlarged, black tubercles dorso-laterally, some of the tubercles being spined and the rostrum shows only a slight tendency to be U-shaped. There is no marginal pleural spine on the sixth somite of the abdomen.

---

* Rec. Aust. Mus. XXII:368.

*74114

Colour.—Body dark-green above, chelae with fingers paler than rest of dorsal surface, brownish; spines of abdomen reddish or whitish with darkened tips; joints of legs dull-reddish; body ventrally flesh-coloured but legs including ischium dark below; great chelae all pale below.

Types.—The types in the Queensland Museum were not available for study. If they should prove to be lost the largest female of the above series and the larger of the two males could be considered as holotype and allotype respectively.

Specimens Examined.—Elaman Creek, Maleny, Queensland (8 October 1953, E. F. Riek), a series of six specimens (2 males, 4 females), deposited in the Australian Museum, Sydney.

Euastacus spinosus, sp. nov.

Diagnosis.—Similar to *hystricosus* and *spinifer* in possessing sharp spines on the dorsal surface of the sixth abdominal somite, telson and uropods; branchiostegites strongly tuberculate, with a dorso-lateral zone of large rather spine-like tubercles; rostrum almost twice as long as broad, somewhat U-shaped, with three or four spines on each rostral carina; great chela below with a large, dark, almost square zone over the basal half or so of the propodus, the zone not extending to the ventral margin; sternal keel blunt and rounded. The basal segment of the protopodite of antenna produced into a sharp spine on anterior margin but mesal margin rounded.

Description of Adult.—Carapace slightly shorter than abdomen; areola wide, about twice as long as wide; cephalic region of cephalothorax slightly more than twice as long as areola; carapace coarsely punctate dorsally; branchiostegites prominently tuberculate, with an irregular zone of large, rather spine-like tubercles dorso-laterally, gradually changing to spines at the margin of the cervical groove; rostrum almost twice as long as broad, pointed, tending to be U-shaped as the rostral carinae are slightly convex; carinae of rostrum with three or four spines, the apical one prominent and directed rather dorsally; post-orbital ridge ending anteriorly in a sharp spine; antenna reaching to the third or fourth somite of the abdomen; abdomen spinose, with three rows of spines and a row of large bosses mesally, except on the first and second somites, first somite with only a marginal spine, second with a marginal series of spines and one mesally, sixth abdominal somite without the marginal spine; the mesally situated boss of the fifth somite is rather spine-like, sixth somite with at least a few, scattered, prominent spines on the dorsal surface; telson with numerous scattered spines similar to those of the sixth somite; inner rami of the uropods with two longitudinal rows of a few prominent spines, outer rami with a single row towards the outer margin (in some cases the rows are reduced to a single spine); great chelae stout, not inflated.

Colour.—Blackish-green above, with the chelae a brighter green, legs pale in part below; great chela below mostly bright green but ischium mostly pale, dull yellowish, dactylus green except at extreme base, propodus with finger green and with a large, almost square green zone over more than the basal half but not extending to the outer margin, in some cases connected with the dark finger, carpus and merus pale in parts laterally; legs mostly dark except for basal portions; sternal keel with the median carina dark and the mesal portions of the lateral processes dark; uropods below somewhat paler than on dorsal surface; joints red; pleural spines mostly red; great chelae with the outer spines, such as propodus below, yellowish; spines of telson, sixth abdominal somite and branchiostegites, dark; tubercles of lower branchiostegites whitish.

Length of holotype male, 200 mm; length of allotype female, 185 mm.

Types.—Holotype male, allotype female and paratype female in the Australian Museum.

Type Locality.—Upper reaches of Hastings River, N.S.W. (October 1953, B. H. Dick).

The species is known only from the type series. The paratype female is gerontic, with reduced, flattened tubercles on the dorso-lateral branchiostegites and more U-shaped rostrum. It has a body length of 240 mm.

The species resembles most closely *hystricosus* Riek from the Maleny plateau of Queensland but can be distinguished most readily on the colour of the propodus of the great chela and on the processes of the basal segment of the protopodite of the antenna.

Euastacus simplex, sp. nov.

Diagnosis.—Resembling *fleckeri* (Watson) in the very reduced abdominal spines but with more obvious tubercles on the branchiostegites and with the rostrum, though short, still bluntly pointed at apex. Sternal keel sharper and lateral processes closer together than in *fleckeri.*

Description of Adult.—Carapace slightly shorter than abdomen; areola wide, a little more than twice as long as wide; cephalic region of cephalothorax slightly more than twice as long as areola; carapace coarsely punctate dorsally; branchiostegites finely tuberculate and with scattered fine hairs, with an irregular double row of somewhat enlarged bosses dorso-laterally; rostrum short and broad, tending strongly to be U-shaped but bluntly pointed at apex, not twice as long as broad; carinae of rostrum without distinct spines, but irregularly raised; post-orbital ridge low, rounded, ending anteriorly in a slight boss, spines below post-orbital ridge reduced to a single small boss; antenna reaching to first or second somite of the abdomen; abdomen with spines very reduced, normally limited to a marginal row of 4-5 on the second somite, occasionally with one spine on the third; a small boss or blunt spine above on the second somite; telson and uropods without additional spines dorsally; great chelae stout, the fingers short and constricted.

Colour.—Almost black above; abdominal spines and tubercles of branchiostegite bright red; lower half of propodus of first periopods red, fading to blackish dorsally; spines on merus and carpus red at apex; antennal scale white over outer half, greenish-black over inner half.

Ventrally, body whitish tinged with red at the bases of the legs; great chelae with propodus, except at ventral margin, bright, almost pillar-box, red, so too, to some extent is the dactylus.

Length of holotype male, 115 mm; length of allotype female, 135 mm.

Types.—Holotype male, allotype female and paratype female in the Australian Museum.

Type Locality.—Fifteen miles N. of Armidale, N.S.W. (25 March 1954, E. F. Riek).

The species is described only from the type series but is known to occur also at Bullock Creek, east of Armidale.

Euastacus neohirsutus, sp. nov.

Diagnosis.—Differing from *hirsutus* in the less hirsute body with the dorsum of cephalon smooth, with widely spaced punctures and the chelae and ventral body not densely hirsute.

Description of Adult.—Carapace slightly shorter than abdomen; areola wide, a little more than twice as long as wide; cephalic region slightly more than twice as long as areola; carapace dorsally smooth on cephalic region with the punctures small and widely spaced; branchiostegites, areola and cephalon laterally densely hirsute; rostrum pointed, not twice as long as wide; rostral carinae generally with three teeth; post-orbital ridge ending anteriorly in a spine; spines below post-orbital ridge normal; antenna reaching to the third or fourth somite of the abdomen; abdomen setose, less so at meson, with only the marginal pleural spines, well developed only on 2-4, occasionally with small bosses above on somites 4-6; telson and uropods densely hirsute except at base; great chelae stout, not densely hirsute; ventral surface of body rather smooth, dense hairs only anterior to mouth.

Colour.—Dorsally abdomen dull grey-green, cephalothorax with more brown; great chelae coloured as cephalothorax but spines and fingers blue; apex of merus and most of carpus blue-green; antennal scale blue.

Ventral surface of legs bright red over basal portion (coxopodites and ischium); spines of merus and carpus of great chela yellowish-red, fingers blue; sternal keel with median carina and lateral processes dark.

Abdominal pleura blue, particularly ventrally.

In some specimens the dorsal surface showed more red, as occurs ventrally.

Length of holotype male, 70 mm; length of allotype female, 85 mm.

Types.—Holotype male, allotype female and paratypes in the Australian Museum.

Type Locality.—Twenty miles W. of Dorrigo, N.S.W. (20 March 1954, E. F. Riek), a long series.

Locality Records.—Dorrigo N.S.W. (21 March 1954, E. F. Riek); New England National Park (19 March 1954, E. F. Riek), at top.

Females are mature at a body length of about 4 inches. One specimen from the New England National Park has four genital apertures, the normal two male apertures and a female aperture on the left side of both the third and fourth periopods so that there are three genital apertures on one side and only one on the other.

Genus **Euastacoides**, gen. nov.

Genotype *Euastacoides setosus*, sp. nov.

Resembling a juvenile *Euastacus* but differing as follows. Propodus of great chela below with only a single row of poorly developed spines; abdomen without spines but with dense setae on the pleura. In gill structure and telson the genus resembles *Euastacus*. Male genital papilla calcified as in *Euastacus*.

Although the genus appears to be closely allied to *Euastacus* it forms a well-differentiated group of species, all of small size, occurring in south-east Queensland. At some localities species of the two genera occur in association.

Key to the Species of *Euastacoides*.

1. Squame of antenna expanded in middle, widest at or distad of middle; rostrum almost parallel-sided till close to apex 2

— Squame of antenna not expanded, widest at or near base; rostrum tapering almost regularly (basal spine of antenna reaching at least one third of distance along squame; spine at apex of median carina of inner ramus of uropod ending distinctly before the margin; interantennal spine with smooth sides, at least twice as long as wide) ..... *setosus*, sp. nov.

2. Basal spine of antenna very small, limited to the basal curvature of base of squame; spine at apex of median carina of inner ramus of uropod ending close to margin, with the apex of spine reaching the margin; interantennal spine with wavy margins, at least twice as long as wide ..... *maidae*, sp. nov.

— Basal spine of antenna reaching at least one quarter of distance along squame; spine at apex of median carina of inner ramus of uropod marginal, stout, apex extending well beyond margin; interantennal spine with margins slightly wavy, only slightly longer than wide ..... *urospinosus*, sp. nov.

Euastacoides setosus, sp. nov.

Diagnosis.—Squame of antenna not expanded, widest at or near base; rostrum tapering almost regularly; spine at apex of median carina of inner ramus of uropod ending distinctly before the margin; basal spine of antenna reaching at least one third of distance along squame; interantennal spine with smooth sides, at least twice as long as wide.

Description of Adult.—Carapace above and laterally densely setose, the punctures above deeper, laterally the setae tending to arise from small tubercles; carapace slightly shorter than abdomen, about as high as broad; cervical groove deeply impressed, branchio-cardiac grooves faint, distinct anteriorly; areola two and a half times as long as wide; rostrum only slightly longer than wide at base (measured at the hind margin of the orbital excavation), tapering rather regularly to apex, without distinct rostral carinae but with a row of four spines on each side and several tufts of stout setae continued back beyond the level of the post-orbital spine; post-orbital ridge short, grooved above, ending anteriorly in a sharp spine; eyes large, almost half as wide as the rostrum at its base; antennule with the inner flagellum distinctly shorter and weaker than the outer; antenna reaching only to the fourth or fifth somite of the abdomen; sternal keel blunt, with a slight, rather rounded, median, longitudinal carina, processes between the first three pairs of periopods strongly raised, almost parallel, processes between fourth periopods large, sloping, with a laterally directed carina, fifth periopods wide apart, processes between them stout, laterally strongly raised and tapered; abdomen almost as wide as cephalothorax; telson with apex evenly rounded, but rather tapered, the marginal spine at between the apical third and quarter, inner rami of uropods rather truncate, the median, longitudinal carina produced into a sharp spine clearly ending before the margin, spine of the outer margin stout, almost at outer apex, outer rami with a series of eight or nine spines along the transverse suture, the median spine the largest, outer rami with the median, longitudinal carina weakening beyond the transverse suture and not continued to the margin; telson and uropods densely hirsute; great chelae with dense tufts of stout setae on both upper and lower surfaces, propodus above mesally with a row of from three to five, rarely two, stout spines, a very reduced, single row of spines below; carpus above with a distinct sulcus, with distinct spines, three or four, on the meso-dorsal margin, the second one usually the largest, with several spines below; merus with distinct spines above towards apex.

Colour.—Nondescript colouring; pale flesh below, darker coloured above, slightly red at joints.

Length of holotype male, 68 mm; length of allotype female, 77 mm.

Types.—Holotype male, allotype female and paratype males and females in the Australian Museum.

Type Locality.—Mt. Glorious, Q. (4 October 1953, E. F. Riek), from small stream in rain-forest.

A series of twenty-eight specimens ranging in size from 47 mm to 80 mm from the type locality. Specimens are most probably mature at 60 mm from an examination of the chelae and are certainly so at 70 mm from the shape of the female abdomen.

Euastacoides maidae, sp. nov.

Diagnosis.—Squame of antenna expanded in middle, widest at or distad of middle; rostrum almost parallel-sided till close to apex; spine at apex of median carina of inner ramus of uropod ending close to margin, with the apex of the spine reaching the margin; basal spine of antenna very small, limited to the basal curvature of the base of the squame; interantennal spine at least twice as long as wide, with wavy margins.

Description of Adult.—Carapace above and laterally densely setose; carapace about as high as broad; cervical groove deeply impressed, branchiocardiac grooves faint, distinct anteriorly; areola twice as long as wide; rostrum only slightly longer than wide at base, with almost parallel sides after the basal contraction, contracting rapidly at the rather rounded apex, without distinct rostral carinae but with a row of four or five blunt spines and several tufts of stout setae, spines continued back beyond the orbital excavations almost to the level of the post-orbital spine; post-orbital ridge, grooved above, ending anteriorly in a sharp spine, in some cases with a few tubercles below and one more or less behind the post-orbital ridge; eyes large, almost half as wide as the rostrum at its base; antennule with the inner flagellum distinctly shorter and weaker than the outer; antenna reaching only to the fourth or fifth somite of the abdomen; sternal keel blunt, similar to that of the type species but the raised portion of the processes between the third periopods distinctly diverging; abdomen almost as wide as cephalothorax; telson with apex evenly rounded, but rather tapered, the apical spine at between the apical third and quarter, inner rami of uropods rounded, the median, longitudinal carina produced into a sharp spine which ends at the margin, spine of the outer margin stout, clearly before the level of the median spine, outer rami with a series of eight to ten spines along the transverse suture, the median spine the largest, outer rami with the median, longitudinal carina weakening beyond the transverse suture and not continued to the margin; telson and uropods densely hirsute; great chelae with dense tufts of stout setae on both upper and lower surfaces, propodus above mesally with a row of two or three spines, a very reduced, single row of spines below; carpus above with a distinct sulcus, with four spines on the meso-dorsal margin, the first much the largest, with two or three spines below; merus with distinct spines above towards apex.

Colour.—Rather nondescript with some bluish tinge on abdomen and great chelae.

Length of holotype male, 62 mm; length of allotype female, 55 mm.

Types.—Holotype male and allotype female in the Australian Museum.

Type Locality.—Upper reaches of Currumbin Creek, south-east Queensland (1 October 1953, E. F. Riek), in rain-forest.

Only the type specimens are known. They were collected in association with *Euastacus sulcatus* Riek and a second species of *Euastacus* of which only juveniles were seen.

Euastacoides urospinosus, sp. nov.

Diagnosis.—Squame of antenna expanded, widest in middle; rostrum with almost parallel sides till close to apex; spine at apex of median carina of inner ramus of uropod marginal, stout, apex extending well beyond margin; basal spine of antenna reaching at least one quarter of distance along squame; interantennal spine only slightly longer than wide, with margins slightly wavy.

Description of Adult.—Carapace above and laterally densely setose, carapace slightly shorter than abdomen, about as high as broad; cervical groove deeply impressed, branchiocardiac grooves faint; areola twice as long as wide; rostrum channelled above, with distinct rostral carinae so that rostrum appears relatively longer being twice as long as wide at the rather narrow base, rostrum with almost parallel sides, tapering more rapidly at the apical third, rostral carina with only one distinct, rounded spine towards apex but with two less clearly defined towards base, the rostral carinae not continued back to the level of the post-orbital ridges; post-orbital ridge short, channelled above, ending anteriorly in a sharp spine, a distinct spine behind and somewhat below the post-orbital ridge; eyes large, almost as wide as the rostrum at its base, but relative to other structures rather similar to those in the other two species; antennule with the inner flagellum distinctly shorter and weaker than the

outer; antenna missing; sternal keel blunt, similar to that in *maidae*; abdomen about as wide as cephalothorax; telson with apex evenly rounded, but rather tapered, the marginal spine at the apical third, inner rami of uropods rounded, the median, longitudinal carina produced into a sharp, stout spine at the margin, its apex extending well beyond the margin, spine of the outer margin weak, outer rami with a series of nine to eleven spines along the transverse suture, the median spine slightly the largest, outer rami with the median, longitudinal carina weakening beyond the transverse suture and not continued to the margin; telson and uropods densely hirsute; great chelae with dense tufts of setae on both upper and lower surfaces, propodus above mesally with a row of four spines, a very reduced, single row of spines below; carpus above with a distinct sulcus, with three distinct spines on the meso-dorsal margin, the first much the largest, with one or two spines below; merus with distinct spine above towards apex.

Colour.—Nondescript colouring with the fingers of the great chelae black.

Length of holotype male, 36 mm.

Type.—Holotype male in the Australian Museum.

Type Locality.—Obi Obi Creek, Maleny, Q. (8 October 1953, E. F. Riek), from cleared rain-forest section of the creek which is now open grazing country.

Only the holotype is known and though possibly not fully mature it shows many distinctive characters. The species occurred in association with *Euastacus* sp. (juvenile only) and *Cherax rotundus* Clark.

Cherax esculus, sp. nov.

Diagnosis.—Sternal keel with lateral processes to third and fourth periopods rounded below as in *destructor* and *albidus;* areola narrow, four to six times as long as broad, sides converging in middle; post-orbital ridges rounded, anteriorly with a rounded spine not connected with the remainder of the ridge; telson with apical portion rounded, semi-circular; branchiostegites obviously tuberculate.

Description of Adult.—Other characters much as in *destructor,* the rostrum tapering gradually, the rostral carinae not produced into spines.

Colour.—The normal grey-green of most species.

Length of holotype male, 78 mm; length of allotype female, 80 mm.

Types.—Holotype male, allotype female and five paratypes in the Australian Museum.

Type Locality.—Peel River at Nundle, N.S.W. (27 March 1954, E. F. Riek).

The species is known only from the type locality.

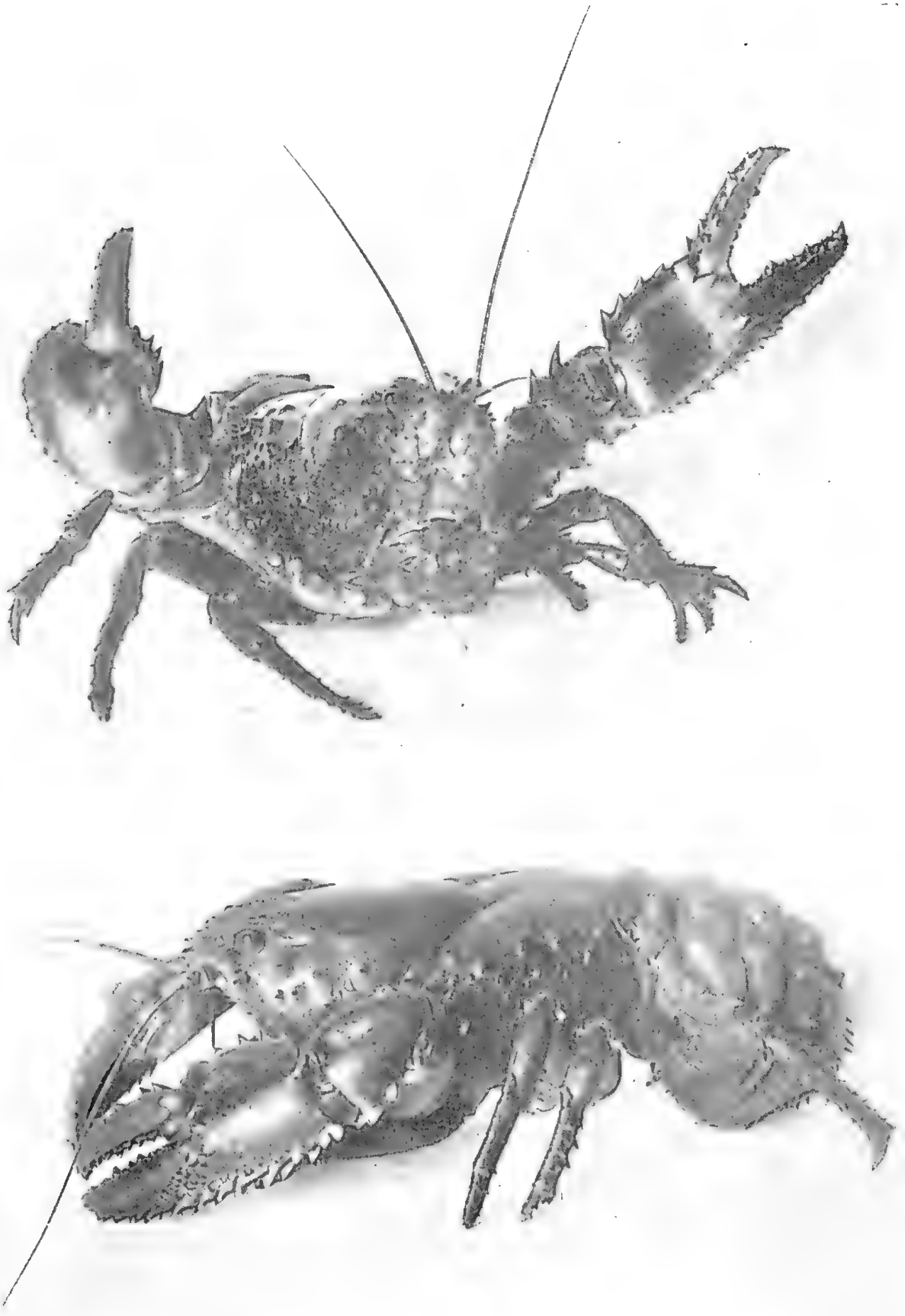
ACKNOWLEDGMENT.

The excellent photographs for Plate 1 were prepared by Mr. Howard Hughes, official photographer of the Australian Museum.

EXPLANATION OF PLATE 1.

Euastaeus spinosus, sp. nov. Two views from life of allotype ♀ ; length of specimen, 185 mm.

Sydney: A. H. Pettifer, Government Printer—1956.



A REVISION OF THE NEW SOUTH WALES LEPTONIDAE (MOLLUSCA: Pelecypoda)

(Figs. 1-27)

By CHARLES F. LASERON, F.R.Z.S.

(This research has been assisted by a grant from the Science and Industry Endowment Fund.)

INTRODUCTION.

The group of bivalves dealt with in this paper has been classified differently by Australasian conchologists. Hedley in his check list, 1918, used Leptonidae as a family name. Powell in "Shellfish of New Zealand", 1937, divided the group into two families Lasaeidae and Erycinidae. Cotton and Godfrey, "The Mollusca of South Australia", 1938, used Leptonacea as a superfamily, divided into two families, Leptonidae and Montacutidae. Powell again, in a second edition, 1946, reverted to the single family Leptonidae.

That arrangement is followed here. The group, whether considered as a family or superfamily, seems a natural one, and the characters, both anatomical and of the shell, are reasonably definable.

Many of the genera are nestling, others are reputed to be either commensal or parasitic, but the latter habits have not been noticed in any of the Peronian forms. Shell characters which may be noted are the small size, thin cellular crystalline texture, and generally fine concentric sculpture. The colour is mainly white or yellow. A thin periostracum may be present. They are equivalve, sometimes gaping, inequilateral, but often nearly equilateral, the posterior end sometimes longer than the anterior. The ligament is rarely external, and when present is weak, leaving no impression on the shell. The resilium is internal, generally in a subumbonal pit, but with no chondrophore. The hinge plate is narrow, with one or two cardinal teeth in each valve, or they may be quite missing in one valve; the cardinals in the other valve fitting into notches on either side of the resilium; laterals may be present, but are generally weak. The adductors are peripheral and subequal, and the pallial line is entire.

All the genera placed by Hedley in the Leptonidae are discussed in this paper with the exception of the minute genus *Notolepton* Finlay. There is considerable doubt as to the exact classification of *Notolepton*, and it is possible that, together with *Micropolia* Laseron, its affinities are with *Cyamiomactra* Bernard rather than with the Leptonidae. In any case I have already discussed both genera in an earlier paper (Laseron 1953).

There is also considerable doubt about the systematic position of *Benthoquetia* Iredale. Cotton placed it near *Montacuta* Turton, but both Hedley and Iredale referred the type species to the Myacidae.

In the preparation of this paper my thanks are again due to Mr. Tom Iredale for his generous advice and for checking the material in the Australian Museum at a time when my own ill health confined me to my home. All the types as well as specimens illustrated have been presented to the Australian Museum.

Genus **Marikellia** Iredale, 1936.

Type species, *Kellia solida* Angas.

Iredale (1936) pointed out that the type species of *Kellia* Turton, s.s., was really the common little gregarious shell known previously as *Lasaea* Brown, and that Kellia must replace *Lasaea* in nomenclature. He introduced *Marikellia* as a new generic name with *Kellia solida* Angas as the type species. Cotton and Godfrey (1938) supplied a full generic description of *Marikellia* from which the following characters may be emphasised: The smooth, white, more or less oval inflated inequilateral shell, the hinge with its internal ligament and wide resilifer, the left valve with a conical tooth in front and a lamelliform tooth anterior to that, a lamelliform tooth behind the resilifer, the right valve with a lamelliform tooth both in front and behind, the adductor scars subequal, the pallial line entire.

All the New South Wales species conform to this description and the genus appears to be a natural one with well marked limitations. It appears also to be restricted to shallow water, often living above the limits of low tide, both on the outer coast and within the harbour. A common habitat of several of the species is nestling within masses of the common hairy mussel, *Trichomya hirsuta* Lamarck, which grow on the foreshore reefs just above low tide level.

Marikellia rotunda (Deshayes).

(Figs. 1, 1*a*, 1*b*, 1*c*)

Erycina rotunda Deshayes, 1855, Proc. Zool. Soc. Lond., 181.

This species appears on the New South Wales List as *Kellia suborbicularis* Montagu, an English shell considered until recently to have a world wide range. Most present day conchologists, however, discount this view. The type locality of *M. rotunda* is Moreton Bay, the northernmost limit of the Peronian Province. Hedley (1905) having stated that Smith "has repeatedly expressed his conviction that *Erycina rotunda* Deshayes from Moreton Bay, Queensland, cannot be separated from *K. suborbicularis*", synonymized them (1917) under the latter species. Iredale (1936) preferred to adopt *E. rotunda* in connection with the genus *Marikellia*, a course here followed. Further examination shows that there are actually two forms under this name in New South Wales, one of which is here described as new. What is taken as the typical *M. rotunda* is a rounded shell, nearly as high as long, only moderately inflated, rather oblique, with the umbos well forward and pointing anteriorly. The anterior margin is somewhat flattened, this character varying somewhat, some specimens from the outer beaches having it nearly straight. The left valve has two prominent anterior teeth, the right valve only one, and each valve has the usual lamellar posterior tooth. The specimen figured was living in mussel beds, Balmoral, Port Jackson; its length is 11.7 mm; height 10.6 mm; and thickness of the united valves about 8 mm.

Marikellia jacksoniana (Smith).

(Figs. 2, 2*a*, 2*b*, 2*c*)

Kellia jacksoniana Smith, 1844, Zool. Coll. *Alert*, 105, pl. 7, fig. F.

This is the commonest New South Wales species. It is found chiefly within the harbours, being particularly abundant living in beds of the common mussel between tide marks in many parts of Port Jackson. The specimen figured came from North Harbour and is 13 mm long, 9 mm high and the thickness of the united valves about 7 mm. Compared with *M. solida* the shell is thinner, with a yellow tinge when alive, the growth lines are more apparent, the umbos are smaller and more anteriorly placed, the height is greater compared to the length, and it is less inflated.

Marikellia solida (Angas).

(Figs. 3, 3*a*, 3*b*, 3*c*)

Kellia solida Angas, 1877, Proc. Zool. Soc. Lond., 176, pl. 26, fig. 25.

This is a common species, distinguished by its solid, smooth, porcellaneous, polished shell, regular oval shape, elongated, with sub-central inflated umbos. It is generally found on the outer beaches right along the coast, the length of the isolated valves generally about 8 or 9 mm. The specimen figured is larger than usual and was found alive in beds of the common mussel in North Harbour, Port Jackson. Its length is 12 mm; height 9.4 mm; and the thickness of the united valves about 8mm. A feature of this specimen is the minute, perfectly round prodissoconch, still visible on the tip of the overhanging umbo.

Marikellia tumida sp. nov.

(Figs. 4, 4*a*, 4*b*, 4*c*)

Shell comparatively large, rotund, as high as long, slightly oblique, umbos very large and tumid, not so far forward as in *M. rotunda*, apices overhanging the hinge and twisted forwards. Colour white with a yellowish tinge, surface shiny, texture sub-translucent, concentric growth lines fine and prominent. Adductor muscle scars and pallial line very faintly impressed and hardly visible. Left valve with a sharp, projecting isolated conical tooth just in front of the umbo, and anterior to this a larger, less projecting tooth attached to the hinge plate. The posterior lamellar tooth is narrow and not prominent. Right valve with one prominent anterior tooth, and a prominent narrow, transverse posterior tooth, above which is a transverse deep slot for the reception of the corresponding tooth on the other valve. Length 13.2 mm; height 13 mm; thickness of united valves about 9 mm.

Locality.—Living in mussel beds, Shark Island, Port Jackson (type); on beach at Point Halliday, North Coast.

Remarks.—This species is closely related to *M. rotunda*, from which it can, however, be readily separated by its huge, tumid umbos, and its greater height in relation to its length. It is not quite so oblique, and the anterior margin is rounded not flattened.

Marikellia adamsi (Angas).

(Figs. 5, 5*a*, 5*b*, 5*c*)

Lepton adamsi Angas, 1867, Proc. Zool. Soc. Lond., 910, pl. 44, fig. 11.

This is an oval shell, thin, white and lustrous, with barely discernible growth lines, and the least inflated of all the local species. The umbos are comparatively small and sharp and placed about one-third from the anterior end. The hinge plate and teeth are small, but conform otherwise to the generic characters. It is not uncommon on the outer beaches, but so far we have not found it alive. The specimen figured is from Manly Ocean Beach, Sydney, is 14.5 mm long, 11 mm high and the thickness of the united valves is about 5.6 mm.

Genus **Fronsella** gen. nov.

Type species, *Fronsella adipata* sp. nov.

Like *Marikellia* in general form, but less inflated, and with the anterior end longer than the posterior. Hinge plate narrow; a small anterior conical tooth and a lamellar posterior tooth in each valve with the wide resilifer between. The prolongation of the anterior end at once separates this from *Marikellia* and gives it quite a different facies.

Fronsella adipata sp. nov.

(Figs. 6, 6*a*, 6*b*)

Shell of medium size, yellowish white, thin, polished, regularly oval, not greatly inflated, umbos about one-third from the posterior end, shell greatly produced in front. Umbos comparatively small and sharp, erect. All margins rounded. Growth lines faint, surface nearly smooth and shining. Adductor muscles distinct, the anterior the larger, pallial line not close to margin. Prodissoconch comparatively large, round and raised. Hinge as in generic description. Length 8 mm; height 5.4 mm; depth of single valve about 1.5 mm.

Locality.—Dredged in Gunnamatta Bay, Port Hacking, south of Sydney, one left valve.

Remarks.—By its hinge resembles *Marikellia*, but differs from all local species of that genus by the posterior position of the umbos and the great extension of the anterior end. The comparatively flat shell, small umbos and the outline recall *M. adamsi*, but the umbos well to the rear of course at once separate it.

Fronsella reversa sp. nov.

(Figs. 7, 7*a*)

Shell of medium size, oval, white, thin and translucent, the muscle scars visible from the exterior of the shell. Umbo not inflated, about one-third from the posterior end, pointing forwards. All margins rounded, but the anterior end slightly tapered, and with the surface of the shell slightly angled anteriorly. Hinge of right valve with a wide, very narrow subumbonal resilifer, with a small tooth in front and a lamellar lateral tooth behind. Adductor scars subequal, pallial line not close to margin. Length 7 mm; height 5 mm; depth of single valve approximately 1.4 mm.

Locality.—6 fathoms, North Harbour, Port Jackson.

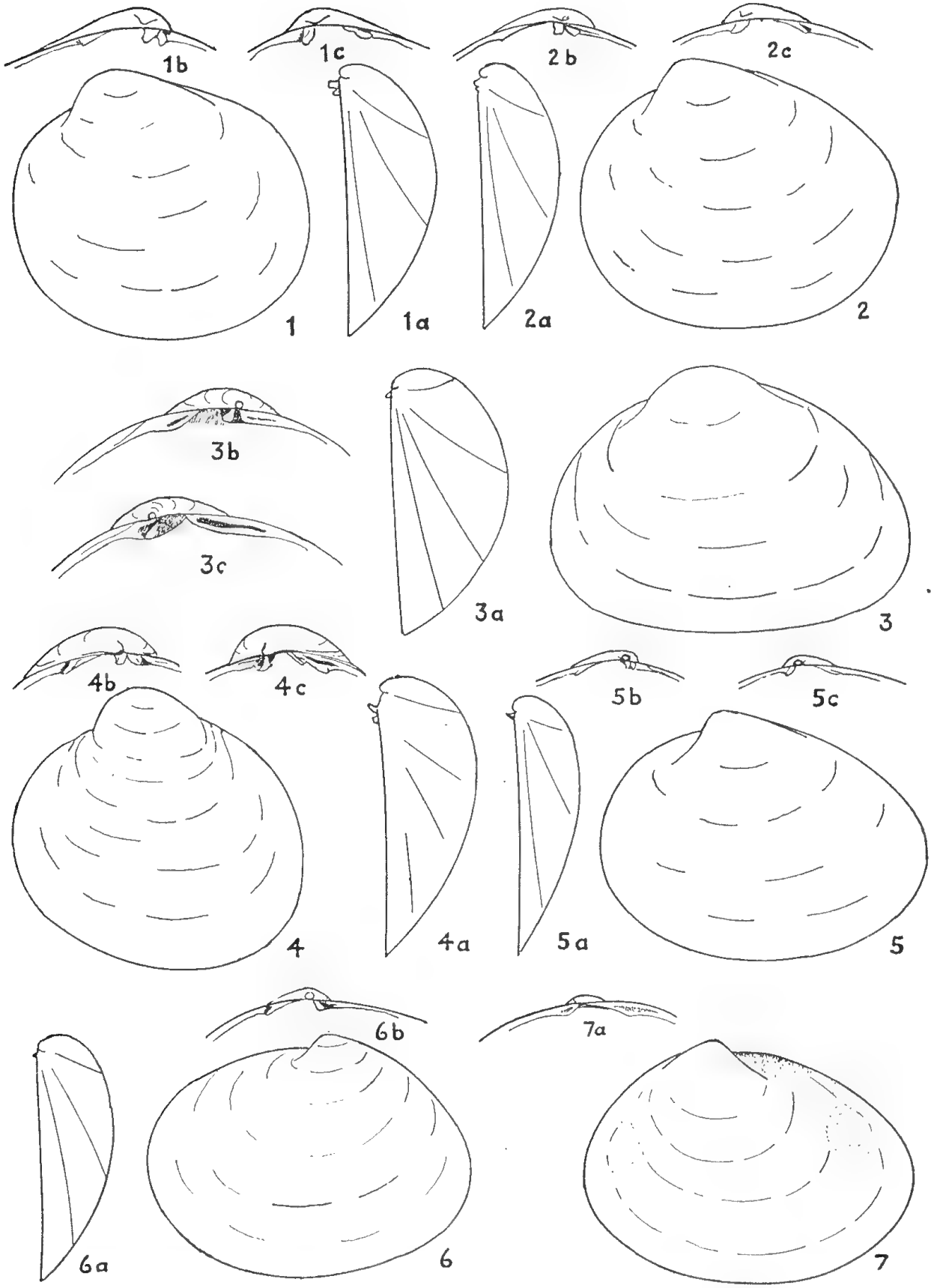
Remarks.—This is very close to *F. adipata*, but differs in outline, the umbos are rather finer, the shell is slightly keeled and is thinner, with the adductor muscles visible from the exterior.

Genus **Parvikellia** gen. nov.

Type species, *Parvikellia isolata* sp. nov.

Like *Marikellia* with an oval, thin, white highly polished and inflated shell, sculpture confined to faint, concentric growth lines, but with a weaker hinge and small erect, nearly central umbos. The right valve is the only one known, and this has a subumbonal triangular resilifer, in front of which is a single cardinal tooth bearing a slight hook, and behind one fairly prominent lateral. Adductor scars and pallial line not impressed. A second species, described here as *P. depressa*, is known from the left valve only, and if this is congeneric, it completes the picture of the hinge, showing that the left valve has two small cardinals and two laterals.

Parvikellia is one of many small white shells with superficial resemblance which previous authors have been content to place in either *Lepton* Turton or *Montacuta*, apparently because they would not fit in elsewhere. Actually it is doubtful if either of these north Atlantic genera occurs in Australian waters, and the result has been to confuse many quite different generic types. Cotton and Godfrey have used both *Lepton* and *Montacuta* for South Australian shells, but by the descriptions given all need further revision and division generically. Of these *Montacuta meridionalis* Tate is I think definitely congeneric with *Parvikellia*.



Figures 1 to 7.

1, *Marikellia rotunda* Deshayes, left valve (1*a*, profile; 1*b*, 1*c*, hinge); 2, *Marikellia jacksoniana* Smith, left valve (2*a*, profile; 2*b*, 2*c*, hinge); 3, *Marikellia solida* Angas, left valve, (3*a*, profile; 3*b*, 3*c*, hinge); 4, *Marikellia tumida* Laseron, left valve (4*a*, profile; 4*b*, 4*c*, hinge); 5, *Marikellia adamsi* Angas, left valve (5*a*, profile; 5*b*, 5*c*, hinge); 6, *Fronsella adipata* Laseron, left valve (6*a*, profile; 6*b*, hinge); 7, *Fronsella reversa* Laseron, right valve (7*a*, hinge).

Parvikellia isolata sp. nov.

(Figs. 8, 8*a*)

Shell broadly oval, nearly equilateral, thin, white, highly polished, somewhat inflated. Margins all regularly rounded. Umbo small, sharp and erect, nearly centrally situated, with a small, distinct rounded prodissoconch. Hinge of right valve with a small triangular subumbonal resilifer, in front of which is a single, conical cardinal tooth, bearing a slight hook at its distal end. No anterior but a single posterior lateral tooth. Adductor scars and pallial line not impressed. Length 6.2 mm; height 5 mm; depth of single valve 1.5 mm approximately.

Locality.—Burrill Lake, two right valves.

Remarks.—This agrees somewhat with the drawing of *Montacuta angasi* Smith, described from a single right valve from Port Jackson, but cannot be reconciled with the description which states the hinge to have two divergent lateral teeth with a triangular space between, and also to have the muscle scars deeply impressed. The general facies is that of a *Marikellia* but it differs from all species of that genus by the small erect centrally situated umbos.

Parvikellia depressa sp. nov.

(Figs. 9, 9*a*)

Shell small, oval, nearly equilateral, thin, glassy and translucent, with traces of a thin brownish periostracum. Umbos nearly central, small and erect. All the margins rounded, but the posterior end rather longer and narrower than the anterior and the ventral margin slightly expanded at about its posterior third. Sculpture of very fine concentric growth lines. Only the left valve known, of which the hinge has a triangular resilifer below the umbo, with two small diverging cardinal teeth and two lateral teeth. The latter, as in *Mysella* Angas, are apparently the thickened edges of the infolded dorsal margin. Adductor scars and pallial line not impressed. Length 5.5 mm; height 4 mm; and depth of single valve approximately 1 mm.

Locality.—5 fathoms, Jervis Bay, N.S.W., two left valves.

Remarks.—This in outline is close to *P. isolata* but differs in details. It is lower in proportion to its length, is flatter, and is thinner and not so highly polished. The hinge cannot be compared, as the types of both species are of opposite valves, and they may not even be congeneric, but complete material is necessary to determine this question.

Genus **Pileatona** gen. nov.

Type species, *Pileatona compressa* sp. nov.

Shell small, thin, trigonal, nearly equilateral, sculpture of concentric growth lines only. Hinge weak, the only valve known (the left ?) with a narrow resilifer and two obscure laterals. Prodissoconch rounded and distinct. Adductor muscle scars and pallial line not impressed.

The weak hinge and thin shell separate this from *Kellia* and the trigonal shape from all other members of the family. The South Australian *Lepton trigonale* Tate may also belong here.

Pileatona compressa sp. nov.

(Figs. 10, 10*a*)

Shell small, thin, yellowish, translucent, trigonal, nearly equilateral, the left (?) valve only known, ventral margin rounded, anterior and posterior margins straighter, converging towards the umbo, dorsal margin short, but flattened behind the umbo. Umbo nearly erect, with a prominent prodissoconch, nearly centrally situated. Sculpture of fine concentric growth lines. Hinge of left valve weak, with a narrow subumbonal resilifer, hinge plate narrow, with two obscure laterals. Length 4.6 mm; height 4 mm; depth of single valve approximately 1.5 mm.

Locality.—40-50 fathoms off Twofold Bay.

Remarks.—As this species is different in form from any other recorded from southern Australian seas I have ventured to propose a new genus and species from a single left valve which may not even be quite mature. Its distinctive characters, however, should make its future recognition comparatively easy.

Genus **Coriareus** Hedley, 1907.

Type species, *Coriareus vitreus* Hedley.

Hedley's description reads: "A genus allied to *Lasaea*, (*i.e.*, *Kellia*), with a weaker, less complex hinge, a larger, thinner, radiately sculptured valve clothed with a thick dense epidermis; second species, *Montacuta semiradiata* Tate."

Coriareus vitreus Hedley.

(Figs. 11*a*, 11*b*; after Hedley)

Coriareus vitreus Hedley, 1907, Rec. Aust. Mus. vi, 301, pl. 56, figs. 28, 30.

The type locality is 80 fathoms off Narrabeen, north of Sydney, and Hedley also records it from 300 fathoms off Sydney, the dimensions of the type being given as length 6.5 mm; height 5 mm; and depth of single valve 1.5 mm.

I have not seen this species, but the full description given, and particularly the radial sculpture and thick epidermis, should make it easy to recognize.

Coriareus jervisensis sp. nov.

(Figs. 12, 12*a*)

Shell white, thin, translucent, regularly oval, with what appear to be traces of an amorphous epidermis. Nearly equilateral, the umbo small and erect, slightly pointing forward, the anterior (?) end slightly longer than the posterior. Margins regularly rounded but the anterior end slightly higher than the posterior. Sculpture of fine growth lines, crossed medially by fine radial threads, closely spaced and becoming obsolete towards the ventral margin. Hinge of right valve with a single small subumbonal cardinal tooth, behind which is a narrow, channelled resilifer, and in front a broad lateral tooth. Hinge of left valve unknown. Adductor muscle scars and pallial line not impressed. Length 7.1 mm; height 5.5 mm; and depth of single valve 1.2 mm approximately.

Locality.—15 fathoms, Jervis Bay, N.S.W., sandy bottom.

Remarks.—This may possibly be the species recorded by Hedley (1907) as *Coriareus semiradiatus* (Tate) as associated with *C. vitreus* from 300 fathoms off Sydney. It is doubtful if the true *C. semiradiatus* occurs in New South Wales, and its acceptance on the Peronian list should be held in abeyance. This species is certainly not *C. semiradiatus*, from which it differs both in shape and sculpture. Its position in *Coriareus* is tentative, and when the hinge of the left valve is known it may need further generic revision.

Genus **Mylitta** d'Orbigny & Récluz, 1850.

Type species, *Mylitta deshayesi* d'Orbigny & Récluz.

Shell small, equivalve, nearly equilateral, nearly circular, almost as high as long, sculpture distinctive, of strong divaricate ribs, adductor scars large, pallial line simple. Hinge with a strong resilium in each valve, left valve with a prominent lamelliform posterior tooth and two small conical cardinal teeth beneath the umbo, right valve with a strong posterior lamelliform tooth and a single, small, subumbonal tooth.

Mylitta is a well defined genus typical of southern Australia, and is also found fossil in the Tertiary (Miocene) of Victoria and South Australia. The nearly circular form and distinctive sculpture make it easily recognizable.

Mylitta tasmanica (Ten. Woods).

(Figs. 13, 13*a*, 13*b*)

Pythina tasmanica Ten. Woods, 1875. Proc. Roy. Soc. Tasm., 162.

The type locality is King Island, and the species has been recorded from New South Wales and Tasmania to Fremantle. There seems little difference between figures published from Tasmania and South Australia, and the New South Wales specimens correspond sufficiently to confirm this wide range. It is not uncommon in shell sand from the ocean beaches, and its distinctive sculpture makes it easy of recognition. The specimen illustrated came from Port Stephens. Its length is 5.8 mm; height 5.2 mm; and depth of one valve approximately 1.5 mm.

Mylitta calva sp. nov.

(Figs. 14, 14*a*)

Shell small, sub-circular, nearly symmetrical, nearly as high as long, white, translucent. Umbos tumid, pointing slightly forward. Sculpture of short, very stout, divaricate ribs, beginning abruptly on both the anterior and posterior sides and continuing to the margins, the interstices crossed by well defined concentric threads, six main ribs on either side with fainter ribs both above and below, about 24 in all, the median portion of the shell from the umbo to the ventral margin smooth and polished. Hinge as in *M. tasmanica;* in the left

valve is a very prominent oblique posterior tooth with two small conical teeth beneath the umbo. Hinge of right valve unknown but probably as in *M. tasmanica*. Length of type 5 mm; height 4.5 mm; and depth of single valve about 1 mm.

Localities.—Shell sand, Port Stephens (type); Manly Beach, Sydney.

Remarks.—In general form and hinge this is practically the same as *M. tasmanica*, but it can be readily separated by the sculpture, the fewer and coarser ribs and smooth central area being constant and characteristic.

Genus **Melliteryx** Iredale, 1924.

Type species, *Erycina acupuncta* Hedley.

Iredale established and introduced *Melliteryx* on the grounds that Lamarck's genus *Erycina* was of uncertain status even for European shells and certainly could not be used for Australian recent molluscs. Cotton and Godfrey (1938) provided a generic description, the main characters being a small, inflated, oval to oblong shell, anterior end slightly longer, tumid umbos, one cardinal and a posterior and anterior lateral tooth in each valve. The surface of the shell is to the eye nearly smooth, but under strong magnification is seen to be punctate, the punctures arranged in curved oblique lines like the surface of a thimble.

Melliteryx acupuncta (Hedley).

(Figs. 15, 15*a*, 15*b*, 15*c*, after Hedley)

Erycina acupuncta Hedley, 1902. Aust. Mus. Mem. iv: 321, fig. 60.

The type locality is 41-50 fathoms off Cape Three Points, north of Sydney, the dimensions given length 2.1 mm; height 1.25 mm. I have not seen this species, but Hedley's excellent figures and description should make it easy to recognize.

Melliteryx helmsi (Hedley).

(Figs. 16, 16*a*, 16*b*)

Erycina helmsi Hedley 1915. Proc. Linn. Soc. N.S.W., xxxix., 701, pl. 80, figs. 37-9.

The type locality is in *Zostera* beds, Deewhy Lagoon, near Sydney, the dimensions given being, length 2.5 mm; height 2.1 mm; depth of single valve .8 mm. The specimen illustrated is from reclamations at Bayview (Pittwater) north of Sydney, its length 1.8 mm, height 1.5 mm, and depth of one valve about .5 mm. Specimens from Burrill Lake are probably more mature and approximate in size to the type. The very solid shell and general purple coloration should make this species easy to recognize.

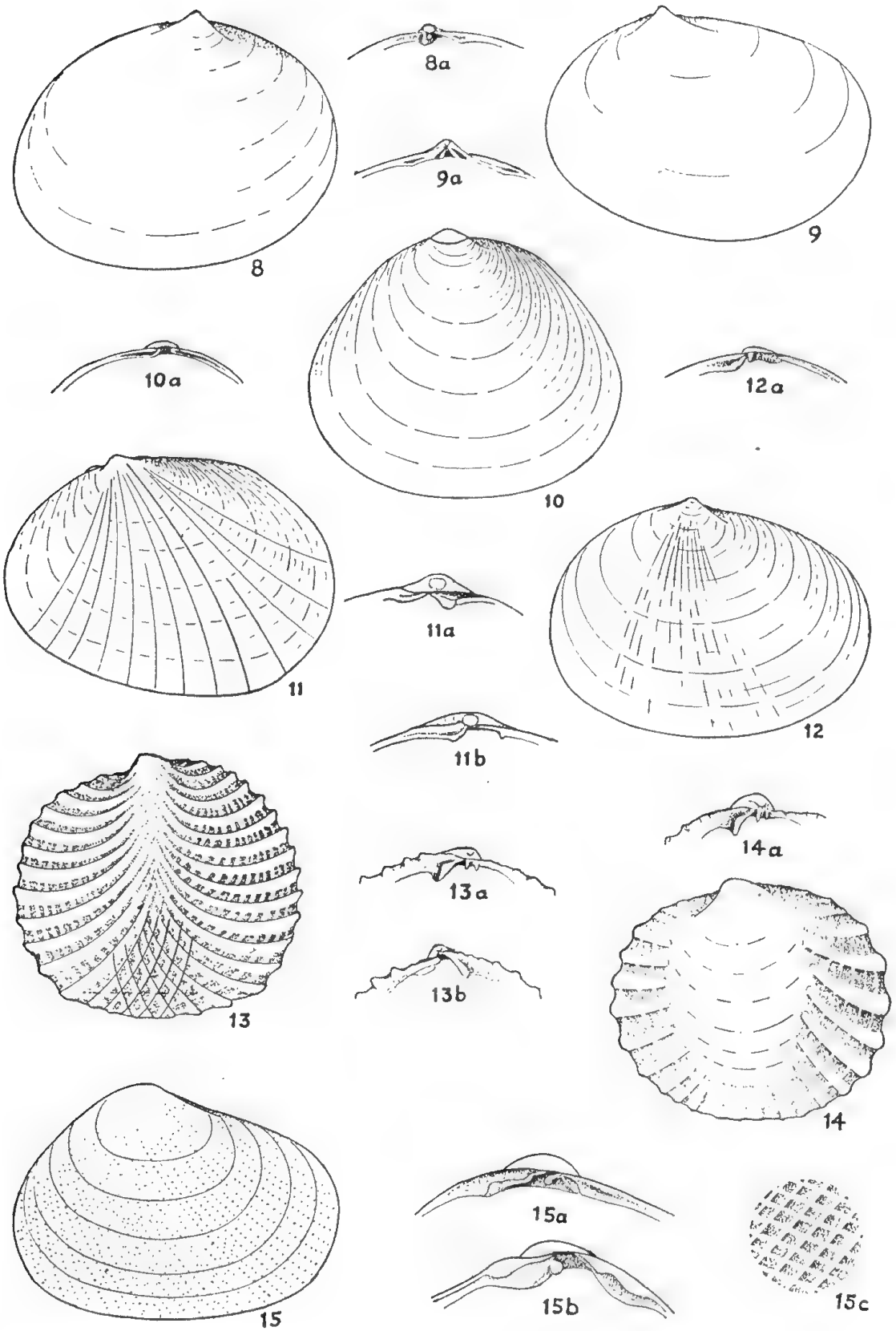
This is an estuarine species, and its known distribution suggests it will be found in other of the coastal lagoons. Its generic position is not quite certain. Hedley states that the external surface is punctate as in *Melliteryx*, but microscopic examination shows that it is rather pustulate, the minute pustules being lunate and arranged with their longer axes concentric and not in oblique lines. The hinge plate is large but the disposition of the teeth is as in *Melliteryx* where it may be provisionally retained.

Genus **Vermitexta** gen. nov.

Type species, *Vermitexta garrardi* sp. nov.

Shell small, equivalve, nearly equilateral, the anterior side slightly the longer, moderately inflated, thin, translucent, sculpture of faint growth lines, the surface otherwise to the eye nearly smooth. Under strong magnification, however, it is seen to be covered with minute, short, broken corrugations, their longer axes arranged radially. Ligament small and internal, the small resilifer subumbonal. Left valve with a small cardinal and two laterals, the right valve with two strong laterals only.

In general form this is near *Melliteryx*, and it has nearly the same type of hinge, but the minute corrugations, instead of a punctate surface, at once separate it.



Figures 8 to 15.

8, *Parvikellia isolata* Laseron, right valve (8*a*, hinge); 9, *Parvikellia depressa* Laseron, left valve (9*a*, hinge); 10, *Pileatona compressa* Laseron, left (?) valve (10*a*, hinge); 11, *Coriareus vitreus* Hedley (after Hedley), left valve (11*a*, 11*b*, hinge); 12, *Coriareus jervisensis* Laseron, left valve (12*a*, hinge); 13, *Mylitta tasmanica* d'Orbigny & Récluz, left valve (13a, 13b, hinge); 14, *Mylitta calva* Laseron, left valve (14*a*, hinge); 15, *Melliteryx acupuncta* Hedley (after Hedley) left valve (15*a*, 15*b*, hinge; 15*c*, surface magnified).

Vermitexta garrardi sp. nov.
(Figs. 17, 17*a*, 17*b*, 17*c*)

Shell small, thin, translucent, with traces of a yellow periostracum, moderately inflated, nearly equilateral, the anterior end slightly the longer, white. Sculpture of faint growth lines; surface under moderate magnification matt, but under higher power minute, closely packed, short and broken corrugations are visible, their longer axes radially arranged. Umbos obtuse and erect. Left valve with a short subumbonal cardinal, and two prominent laterals, right valve with two laterals only. Resilifer small. Adductor muscle scars small, pyriform and subequal, and with the pallial line visible through the shell. Length 4 mm; height 3 mm; depth of united valves approximately 2 mm.

Localities.—Twofold Bay (type collected by Mr. T. Garrard); North Harbour, Port Jackson; a number of specimens dredged on a sandy mud bottom.

Remarks.—In general form not unlike *Melliteryx acupuncta* but differing mainly in the texture of the shell.

Genus **Cicatellia** gen. nov.

Type species, *Cicatellia indenta* sp. nov.

Shell small, white, oval, equivalve, umbos large and inflated, nearly centrally situated, pointing forward. Surface shining but microscopically wrinkled. Left valve, the only one known, with a small centrally situated conical tooth, and two faint laterals. Prodissoconch small, rounded and protuberant.

This is one of the odd Peronian shells which will not fit any of the known genera. The faintly wrinkled surface suggests some relationship with *Vermitexta*, which also has a somewhat similar hinge, but the large tumid umbos and general form are quite distinct.

Cicatella indenta sp. nov.
(Figs. 18, 18*a*)

Shell small, white, thin, translucent, shining, but with the surface under the microscope faintly wrinkled, oval, somewhat inflated, nearly equilateral. Umbos large and tumid, nearly centrally situated, pointing forward, with a distinct, rounded dome-shaped prodissoconch, medially indented, the indentation fading towards the ventral margin. Dorsal, anterior and posterior margins rounded. Hinge of the left valve with a small conical tooth immediately below the umbo, and two faint laterals. Resilifer small. Pallial line and adductors not impressed. Length 4.2 mm; height 3.3 mm; depth of single valve approximately .9 mm.

Locality.—Shell sand, Port Stephens, 3 specimens of left valves.

Remarks.—There is no other species on the coast with which this can readily be confused, though in general form it resembles the juveniles of some species of *Marikellia*.

Genus **Kellia** Turton, 1822.

Type species, *Kellia rubra* Montagu.

Kellia replaces *Lasaea* for the common Australian species previously known as *Lasaea australis* (Lamarck) as apparently *Lasaea* is an absolute synonym of *Kellia* with the same type species (see Iredale, 1936).

Kellia is a distinctive genus with a nearly rotund shell, thick and solid, with strong lateral teeth but no cardinals. The sculpture is concentric, sometimes consisting of strong ribs. Nesting in habit and adhering by a byssus.

Kellia australis (Lamarck).
(Figs. 19, 19*a*, 19*b*)

Cyclas australis Lamarck, 1818, Anim. sans vert., v., 560.

The type locality is generally regarded as King George's Sound, Western Australia. There is still doubt as to whether the eastern Australian species is identical, or whether more than one species occurs in the one locality. There is considerable variation in the New South Wales specimens, but after examining long series from various localities, it seems that this is individual and neither racial nor specific. The chief variation is in the sculpture which typically consists of strong concentric, equally spaced ribs, but some specimens are nearly smooth near the umbos and others towards the ventral margin. The commonest habitat in New South Wales is within *Galiolaria* tubes, where it is invariably found nesting in countless numbers, but it is also found alive in dead oyster shells or in crevices in rocks. The specimen illustrated came from *Galiolaria* tubes in North Harbour, Port Jackson, its length being 6.5 mm; height 6 mm; and depth of united valves approximately 4.5 mm. A useful recognition point is the red colouration of the hinge area internally.

Genus **Borniola** Iredale, 1924.

Type species, *Bornia lepida* Hedley.

Iredale states that *Bornia* of Philippi is of very uncertain status even for European shells, and established *Borniola* in its stead for certain Australian bivalves. No generic description has previously appeared, but the salient characters may be defined as follows: Shell small to medium, flat, inequilateral to nearly equilateral, umbos small and erect, sculpture of growth lines crossed by very fine radial threads. Ligament internal, subumbonal, the resilifer triangular and well defined, flanked in the left valve by two diverging cardinal teeth. Right valve without teeth, the cardinals of the left valve fitting into shelf-like recesses in the sides of the resilifer.

The mechanics of the hinge are similar to that of *Mysella* but there are two cardinal teeth in the left valve instead of one, and the fine radial sculpture is distinctive.

Borniola lepida (Hedley).
(Figs. 20, 20*a*, 20*b*)

Bornia lepida Hedley, 1906, Proc. Linn. Soc. N.S.W., xxx., 543, pl. 32, figs. 22, 23.

The type locality is Manly Beach, Sydney, and it is not uncommon in shell sand on other beaches on the coast of N.S.W., also in dredgings within Port Jackson. The specimen figured came from 14 fathoms off Long Reef, north of Sydney, its length 6.5 mm; height 4.5 mm; and the depth of one valve approximately 1 mm. The nearly symmetrical shell and fine radial sculpture make it easy of recognition.

Borniola filosa (Hedley).
(Figs. 21, 21*a*).

Bornia filosa Hedley, 1903, Proc. Linn. Soc. N.S.W., xxvii., 7, pl. 2, figs. 15-17.

The type was a single left (?) valve from Middle Harbour, Port Jackson, and was probably not mature, its length being only 6 mm. It is seldom taken; I have so far seen only one other specimen—the same valve from reclamations at The Spit, Middle Harbour. This is much larger, its length 15 mm; height 10 mm; and the depth 1.5 mm. It can be readily distinguished from *B. lepida* by the much more asymmetrical shell.

Borniola radiata (Hedley).
(Figs. 22, 22*a*, 22*b*, after Hedley)

Bornia radiata Hedley, 1905. Rec. Aust. Mus. vi, 48, fig. 12.

The type locality is 111 fathoms east of Cape Byron, the dimensions given being height 4.6 mm; length 6 mm; and depth of single valve 1.25 mm. I have not seen this species, but in form it is intermediate between *B. lepida* and *B. filosa*. Hedley figures but does not describe the hinge, and by his figure the left valve has only one and not two cardinal teeth as in the other species.

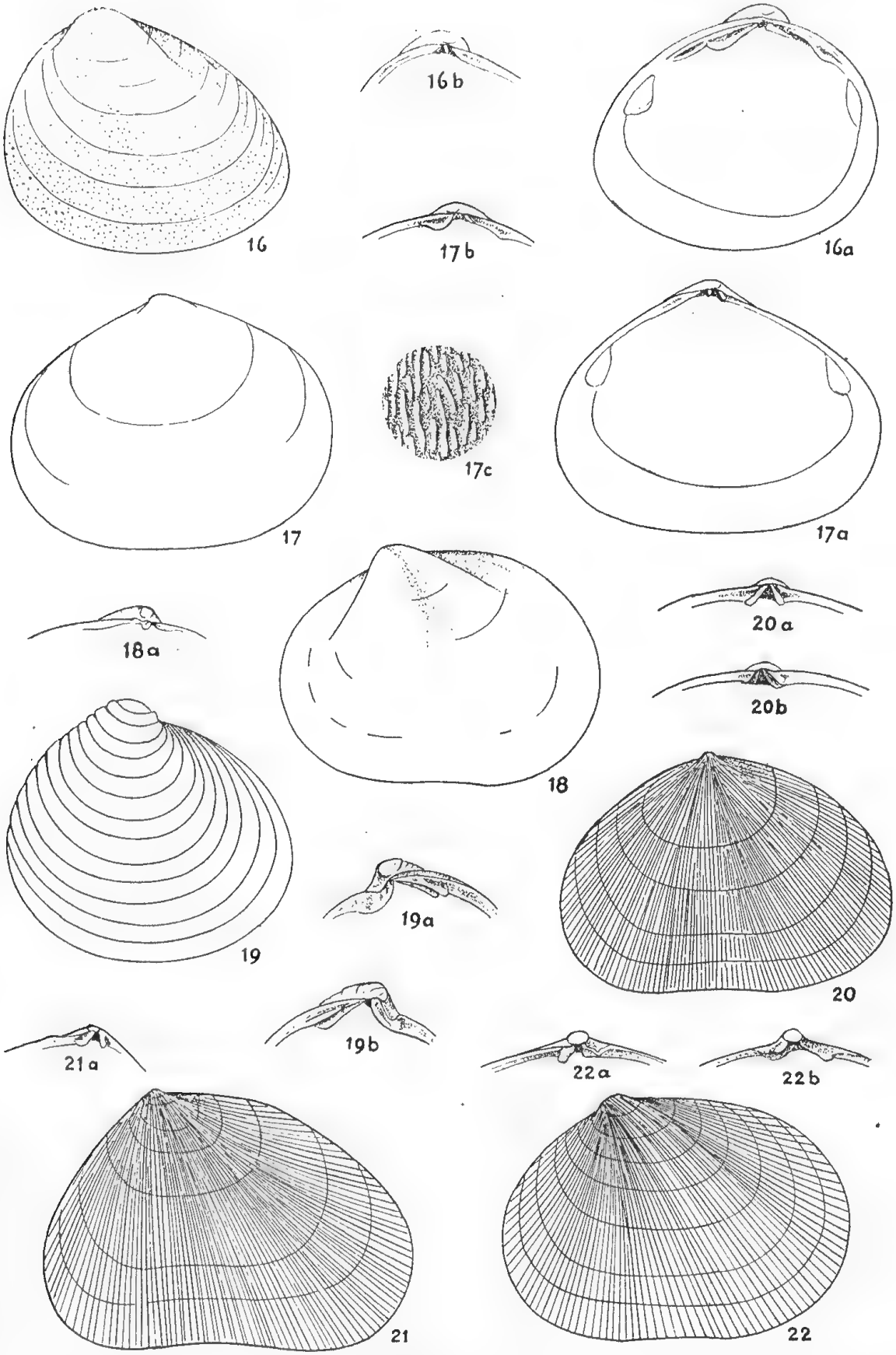
Genus **Mysella** Angas, 1877.

Type species, *Mysella anomala* Angas.

The original description reads: "Shell small, thin, equivalve, inequilateral, quadrately cuneate, concentrically striated. Hinge with a small triangular internal cartilage-pit, close to which is a single small, diverging, subcircular, flattened cardinal tooth in one valve, and with two thin short horizontal lateral processes in the other valve. Siphonal inflection none."

Hedley in his check list (1917) uses *Rochefortia* Velain for this (*M. anomala*) and other species, following Dall, who considered the two congeneric, and that *Rochefortia* had priority. Iredale (1924), however, pointed out that there was no necessity to consider the question of synonymy as *Mysella* has actual priority by several months, and that *Mysella* is a good genus covering a natural group of Australian species. Cotton and Godfrey (1938) have accepted this and used *Mysella* for certain Adelaidean species, and Powell has also used it for others from New Zealand.

Hedley (1917) listed six species under *Rochefortia* but these need considerable revision. *Montacuta angasi* Smith is definitely not a *Mysella* and is dealt with elsewhere in this paper. The typical South Australian species *Mysella donaciformis* Angas evidently does not occur on the New South Wales coast. There are actually two small species, one of which was figured



Figures 16 to 22.

16, *Melliteryx helmsi* Hedley, left valve (16*a*, 16*b*, hinge); 17, *Vermitexta garrardi* Lascron, left valve (17*a*, 17*b*, hinge; 17*c*, surface magnified); 18, *Cicatellia indenta* Laseron, left valve (18*a*, hinge); 19, *Kellia australis* Lamarck, left valve (19*a*, 19*b*, hinge); 20, *Borniola lepida* Hedley, left valve (20*a*, 20*b*, hinge); 21, *Borniola filosa* Hedley, left valve (21*a*, hinge); 22, *Borniola radiata* Hedley (after Hedley), left valve (22*a*, 22*b*, hinge).

by Hedley (1902) as *R. donaciformis*, but neither of which corresponds with the type. The deepwater *Rochefortia lactea* Hedley, conforms to Mysella and is there retained. *Tellimya subacuminata* Smith presents another problem. The type came from the disputed *Challenger* Station, 410 fathoms off Sydney, the figure is of the exterior of one valve only, and the description is very brief, the only information given of the hinge and muscle scars being that they are similar to those of *Montacuta acuminata* Smith, a species from Cape York. Reference to the description of that species, however, shows it to have a pallial sinus, and assuming the comparison to be correct, *T. subacuminata* does not even belong to the Leptonidae. It should probably be expunged from the New South Wales list altogether, but that point does not arise here, as it comes in any case outside the scope of this paper.

A feature not mentioned by Angas in his description, but common to all the species here discussed, is that the horizontal lateral processes in the right valve are caused by a peculiar infolding of the dorsal margin on either side of the umbos, and are in no sense lateral teeth as generally understood. It may be added also that the anterior end is longer than the posterior.

Mysella anomala Angas.

(Figs. 23, 23*a*, 23*b*)

Angas, 1877, Proc. Zool. Soc. Lond., 176, pl. 26, fig. 22.

The type came from black mud, 12 fathoms off Shark Island, Port Jackson, and the specimen illustrated is one from a number dredged in the near vicinity. Its length is 8.6 mm; height 6 mm; and depth of the united valves 3.5 mm. Compared with other species of *Mysella* the rather tumid umbos are useful for recognition. Specimens from the type area are fairly constant, but odd specimens from other localities show a slight variation. One from 30 to 35 fathoms off Crookhaven has the umbonal area still more tumid, but agrees in other characters and is apparently the same species.

Mysella vitrea sp. nov.

(Figs. 24, 24*a*, 24*b*)

Shell small, thin, white, shining, vitreous and translucent. Equivalve, form sub-oval, posterior side longer, umbos fairly prominent, pointing forwards, about one-third from the anterior end. Anterior, posterior and ventral margins rounded, dorsal margin sloping and nearly straight posteriorly, anteriorly slightly concave. Surface shining, the only sculpture fine concentric lines, adductor scars visible externally. Hinge with a triangular subumbonal resilifer in each valve, the left valve with a very strong, flattened, oblique cardinal tooth behind the resilifer fitting into a socket on the side of the resilifer in the right valve. Right valve with no teeth, but the dorsal margin infolded on both sides of the umbo, its edge thickened to simulate lateral teeth. Adductor muscle scars subequal, large but faint. Length 3.6 mm; height 2.8 mm; depth of single valve approximately .7 mm.

Localities.—Dredged, North Harbour, Port Jackson (type); also in Pittwater (north of Sydney); abundant in shell sand, Port Stephens, Jervis Bay and on ocean beaches.

Remarks.—This is apparently the species previously identified as the South Australian *Mysella donaciformis* Angas, and figured as such by Hedley (1902, pl. I, fig. 10-14). It is, however, not nearly so inequilateral, the true *M. donaciformis* having the umbos nearly terminal. It is somewhat variable in its proportions, the length being from one-fifth to one-fourth more than the height. Specimens from Port Stephens are slightly larger, being up to 5 mm in length, and proportionately are rather higher than the type.

Mysella lactea Hedley.

(Figs. 25, 25*a*, 25*b*, after Hedley)

Hedley, 1902. Aust. Mus. Mem., iv, 320, fig. 59.

The type locality is 63 to 75 fathoms off Port Kembla, and the dimensions given by Hedley are length 3 mm; height 1.9 mm. A small white, thin translucent shell, this is more inequilateral than any of the other species. I have not seen specimens, but Hedley's good description and figure should make it easy to recognize.

Mysella spernax (Iredale).
(Figs. 26, 26*a*, 26*b*)

Virmysella spernax Iredale, 1930. Rec. Aust. Mus. xvii, 394, pl. lxiv, figs. 10-12.

Iredale proposed both a new genus and species for a very common shell found on the outer beaches, and also in dredgings from sandy bottoms within Port Jackson. He remarks that it has frequently been confused with *M. anomala* which it in no sense resembles. In this he is quite correct, but a closer comparison could have been made with *Lepton concentrica* Gould which is included in Hedley's check list as *Rochefortia*, No. 199. The type of *L. concentrica* is in the National Museum, Washington, and Hedley (1914) published a drawing of the single valve forming the type supplied by Dr. P. Bartsch. He (Hedley) remarked that the species was possibly "exotic". The drawing, which does not show the hinge, resembles the species here discussed, but differs slightly in shape, and may refer to a different species. In view of this *L. concentrica* can be queried on the New South Wales list.

I do not agree, however, with the separation of *Virmysella* from *Mysella* generically.

The shell figured in Iredale's paper is the harbour (Port Jackson) *M. anomala* with which it has been confused. A note by Brazier states: "Off Shark Island, Port Jackson, 12 fathoms bottom black mud. Specimen sent to Angas Sept. 4, 1874." This is the type locality and the shell is obviously a paratype of Angas's species. The drawing differs from the type and the description of *Mysella spernax*, although the hinge of the latter type is adequately shown. The shell characters and particularly the hinge are characteristically those of *Mysella*. There is the same prominent plate-like cardinal tooth in one valve, fitting into a niche-like recess in the side of the resilifer of the opposite valve, the same infolding of the dorsal margin of this valve with the simulation of lateral teeth, and the adductor muscle scars and the pallial line also agree. *Virmysella* is in my opinion a synonym of *Mysella*.

The specimen illustrated came from 6 to 9 fathoms, Sow and Pigs Reef, Sydney Harbour, from a sandy bottom. Its length is 13 mm; height 10.5 mm; and depth of one valve approximately 2.5 mm. A larger specimen had a length of 17 mm which is about the maximum. It is a slightly variable species, and some specimens are relatively a little longer in proportion to their height.

Mysella cretacea sp. nov.
(Figs. 27, 27*a*, 27*b*)

Shell small, moderately stout, opaque, white, covered with a thin, yellowish grey periostracum. Form suboval, narrowed posteriorly, inequilateral, the posterior end the longest, umbos small, pointing forwards, about one-fourth from the anterior end. Posterior and ventral margins rounded, anterior margin slightly rounded, dorsal margin sloping posteriorly, slightly concave anteriorly. Sculpture fine concentric growth lines. Hinge as in *M. vitrea*, but the cardinal tooth in the left valve relatively not as large, the dorsal margin in the right valve similarly infolded to simulate two lateral teeth. Adductor muscle scars prominent, the simple pallial line thick. Length 7 mm; height 5.5 mm; depth of united valves approximately 2.4 mm.

Locality.—Very common on muddy bottom in 10 feet, Crookhaven, south of Sydney.

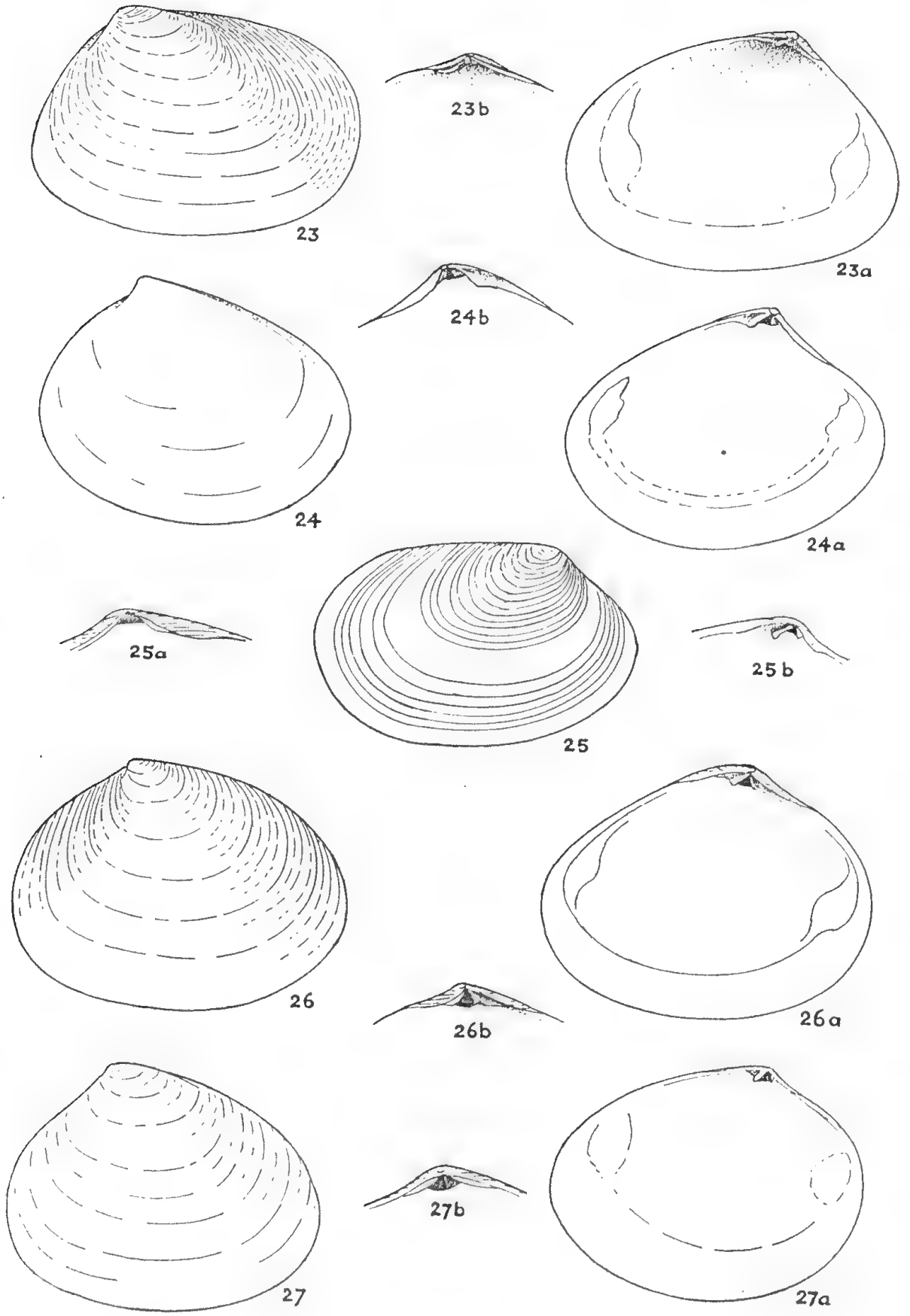
Remarks.—Very close in general form to *M. vitrea*, but readily separated by its stouter shell and texture, which is opaque and rather chalky, not vitreous and translucent. The habitat is estuarine, for Crookhaven is liable to heavy flooding, and few true marine molluscs can retain their footing. *M. vitrea* and *M. cretacea* are I think closely allied species, the one adapted to marine conditions on a sandy bottom, the other estuarine and living in mud.

DOUBTFUL SPECIES.

Montacuta angasi Smith.

Montacuta angasi Smith, 1885. Chall. Zool. xiii., 204, pl. 12, fig. 2.

The type in the British Museum is a single right valve dredged from 2-10 fathoms in Port Jackson, the dimensions given being length 5.5 mm; height 4 mm; depth 2.5 mm. The species has never been definitely recognized since its original description, which in view of the intensive collecting done in Port Jackson is rather remarkable. Two specimens in the Australian Museum, C.6486, provisionally identified as Smith's species and sent to the British Museum for comparison in 1912, are marked as not *angasi*. They resemble the species here called *Fronsella adipata* of which they may be the young. Judging by the original figure *M. angasi* is a species in form somewhat like *Parvikellia* as described here, almost perfectly oval in outline, with small erect umbos, nearly centrally placed. The hinge, however, is quite different with two laterals and no cardinal teeth. Its identity and also its generic position must, therefore, be left for the present in abeyance.



Figures 23 to 27.

23, *Mysella anomala* Angas, left valve (23*a*, 23*b*, hinge) ; 24, *Mysella vitrea* Laseron, left valve (24*a*, 24*b*, hinge) ; 25, *Mysella lactea* Hedley (after Hedley), right valve (25*a*, 25*b*, hinge) ; 26, *Mysella spernax* Iredale, left valve (26*a*, 26*b*, hinge) ; 27, *Mysella cretacea*, Laseron, left valve (27*a* 27*b*, hinge).

Montacuta semiradiata Tate.

Montacuta semiradiata Tate, 1889. Trans. Roy. Soc. S.A., xi, 63, pl. 40, fig. 2.

This species was recorded by Hedley as *Coriareus semiradiatus* from 80 fathoms off Narrabeen, north of Sydney. It is felt, however, that the identification of this with a South Australian species is doubtful, and that when material comes to hand again a new species may be indicated. In the meantime *M. semiradiata* may be considered a doubtful member of the New South Wales fauna.

SUMMARY.

The revision covers all genera, with the exception of *Notolepton* Finlay, of a group of very small New South Wales bivalves. Family classification of the group (Leptonidae) is followed rather than that of superfamily (Leptonacea). Twelve genera and twenty-nine species from New South Wales are discussed. Five gen. nov. and twelve sp. nov. are as follows: *Marikellia tumida* sp. nov., *Fronsella adipata* gen. and sp. nov., *Fronsella reversa* gen. and sp. nov., *Parvikellia isolata* gen. and sp. nov., *Parvikellia depressa* gen. and sp. nov., *Pileatona compressa* gen. and sp. nov., *Coriareus jervisensis* sp. nov., *Mylitta calva* sp. nov., *Vermitexta garrardi* gen. and sp. nov., *Cicatellia identa* gen. and sp. nov., *Mysella vitrea* sp. nov., *Mysella cretacea* sp. nov. Genus *Virmysella* as a synonym of *Mysella* is suggested (syn. nov.); and the probability of the South Australian *Lepton trigonale* being more suitably placed in the Genus *Pileatona* gen. nov.

References.

Cotton, B. C., and Godfrey, F. K., 1938.—Mollusca of South Australia. Part I. The Pelecypoda. Government Printer, Adelaide.

Hedley, C., 1902.—Studies on Australian Mollusca. Part VI. *Proc. Linn. Soc., N.S.W.*, xxvi (1); 709.

————, 1905.—Studies on Australian Mollusca. Part IX. *Proc. Linn. Soc., N.S.W.* xxix (4); 520-546.

————, 1907.—Mollusca from Eighty Fathoms off Narrabeen. *Rec. Aust. Mus.* vi (4); 283-304.

————, 1914.—Studies on Australian Mollusca. Part XII *Proc. Linn. Soc., N.S.W.* xxix (4): 697-755.

————, 1917.—A Check-List of the Marine Fauna of New South Wales. Part I.—Mollusca. *Roy. Soc., N.S.W.*, li. Supplement issued, 1918, 1-120.

Iredale, T., 1924.—Results from Roy Bell's Molluscan Collection. *Proc. Linn. Soc., N.S.W.* xlix: 179-278.

————, 1936.—Australian Molluscan Notes, No. 3. *Rec. Aust. Mus.* xix (5); 274.

Laseron, C. F., 1953.—The Minute Bivalves of New South Wales. *Rec. Aust. Mus.* xxiii: 33.

Sydney: A. H. Pettifer, Government Printer—1956.

FISHES FROM INLAND NEW GUINEA

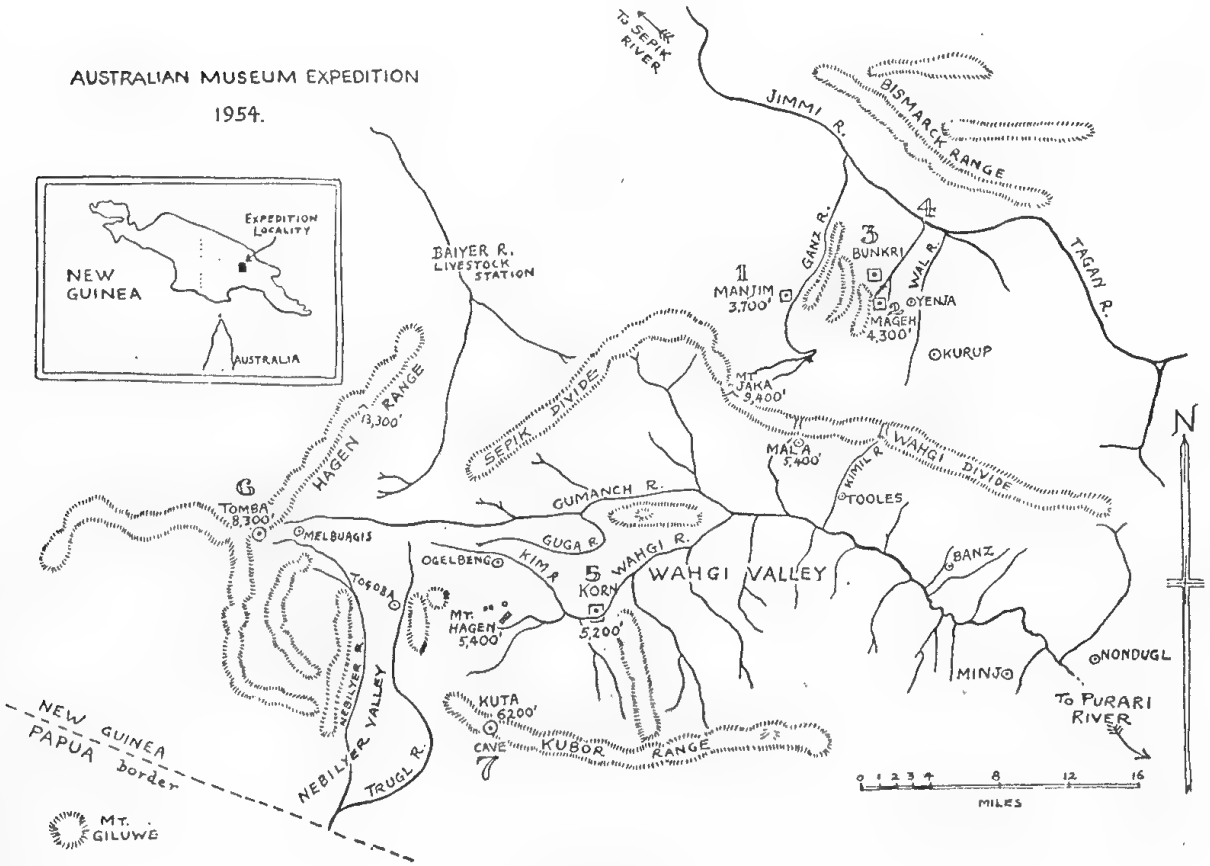
(Plate 2; Figure 1; Sketch map.)

By GILBERT P. WHITLEY, F.R.Z.S.

Curator of Fishes, The Australian Museum.

In 1954, my colleagues, Messrs. Ellis Le Geyt Troughton and Norman Camps, of the Australian Museum, visited inland New Guinea and secured a number of interesting freshwater fishes. The collecting localities of their expedition, in chronological order, were:—

1. "Manjim".—Western bank of Ganz River, 24 miles 3° N. of N.E. of Mount Hagen airstrip. Altitude 3,700 ft (no fishes collected).
2. "Mageh".—Situated between Wahgi Divide and Bismarck Range. Mid-mountain forest. 28 miles 7° E. of N.E. of Mount Hagen airstrip. 18 to 26 July, 1954.
3. "Bunkri".—29 miles 4° E. of N.E. of Mount Hagen airstrip (no fishes).
4. "Jimmi River Camp".—South bank of river; rain forest and grasslands. 33 miles 6° E. of N.E. of Mount Hagen airstrip. Altitude 1,200 ft. 20-27 July, 1954.
5. "Korn Farm".—Banks of Wahgi River, Wahgi Valley, 5 miles E. of Mount Hagen airstrip. Altitude 5,200 ft. 11 July, 1954.
6. "Tomba".—South-west slopes of Mount Hagen range. 15 miles 18° W. of W.N.W. of Mount Hagen airstrip. Altitude 8,300 ft (no fishes).
7. Cave in Kuber Range.—7 miles 8° W. of S. of Mount Hagen airstrip. Altitude 7,800 ft (no fishes).



Sketch map of Australian Museum expedition 1954.

Two fluvifaunulae are represented: Localities 1, 5, and 6 are Leichhardtian with waters flowing to the south of New Guinea; localities 2, 3, 4, and 7 are Gaimardian, having northward-flowing rivers.

*88550

The collection comprised twenty-four specimens, referable to eleven species, all except two new to the Australian Museum collections, and two of the species are evidently new to science. The catfish *Copidoglanis gjellerupi* was taken in both Gaimardian and Leichhardtian watersheds, but all the other species were Gaimardian and most of them belonged to forms already named from the Sepik River system or Lake Sentani. The occurrence of the freshwater eel *Anguilla interioris* in a southward-flowing river is of interest as no Anguillidae are so far known from the Gulf of Papua.

It is hoped that further collections will be made from inland waters of New Guinea and Papua as series of specimens are needed to study variation and to plot the distribution of the species (at present puzzling) in clearer detail.

The freshwater fishes of New Guinea were listed amongst many others in *The Fishes of Oceania*, by H. W. Fowler (1928 and supplements, 1931, 1934 and 1949). No separate list of them has been published: my colleague Mr. Ian Munro, of Cronulla, has a manuscript catalogue which he is preparing with a view to publication elsewhere.

Our knowledge of the freshwater fauna of New Guinea is of such recent growth that, not only is the list of references at the end of this paper practically a comprehensive bibliography of the subject, but the present writer has met many of the men who collected in the wilds there, from Professor L. F. de Beaufort, of Amsterdam, who was with the Dutch expedition to New Guinea in 1903, and visiting European and American naturalists, to the present-day patrol officers who are still opening up new country. Several American and European collectors and naturalists may have taken fishes from the Wahgi Valley to overseas museums. Trout were introduced into the valley by Sir Edward Hallstrom in 1949, and *Tilapia* on private property in 1955.

I am grateful to Mr. Ederic Slater for his photograph (Plate 2), taken from a freshly caught specimen, of the "Jimmi River Fish", *Hemipimelodus*.

A descriptive catalogue of the Australian Museum's series of fishes is as follows:—

Family Anguillidae.

Genus **Anguilla** Shaw, 1803.

Anguilla interioris Whitley.

Anguilla interioris Whitley, 1938: 224 & 233, fig. 1. Gumanj River, New Guinea. *Id.* Ege, 1939; 10-245, pl. i, fig. 2 and text figs. 5, 7, 8, 42-53 (Humboldt Bay, Upper Purari River and Dinawa, Owen Stanley Range). *Id.* Jespersen, 1942: 18 et seq.

Muraena interioris Fowler, 1949; 43.

One (Australian Museum registered No. IB. 3353). *Locality* 4 (see list p. 23), a limestony creek flowing into the Jimmi River; 22 vii, 1954.

Length 2 ft 8½ in.

Coloration mottled. No white edge to caudal, though dorsal is so edged anteriorly; anterior portions of anal cream.

Family Plotosidae.

Genus **Copidoglanis** Gunther, 1864.

Copidoglanis gjellerupi Weber.

Copidoglanis gjellerupi Weber, 1913; 525, 528, 530, 604 & 607. Kaiserin Augusta River, German New Guinea [now the Sepik]. *Id.* Hase, 1914: 539. *Id.* Weber & Beaufort, 1913, 2: 237, figs. 11-12.

Copidoglanis papuensis Hase, 1914; 540, figs. 11-12. Sepik River.

B.8. Di, 7. Caudodorsal more than 50. C. 8 to 10. A *c.* 78 to 86. P.i, 12 or 13. V. 13. C + D + A *circa* 140 to 146.

Head (36 to 45 mm) 5.0 to 5.1, depth (30 to 35) 6.3 to 6.7 in total length (180 to 230). Eye (5) 7.2 to 9 in head, 3.2 to 4.6 in snout (16 to 23 mm) and 2 to 3 in interorbital (10 to 15) which is 3 to 3.6 in head.

Head as deep as broad or slightly broader than deep, its breadth about 1⅓ in its length. Eye situated rather high, mostly in posterior half of head, its margin free. Interorbital convex. Lips thick with partly laminated papillae. Nasal barbel reaching to front or middle of eye. Anterior nostril above upper lip. Mouth wider than interorbital. Lower jaw the

shorter. Maxillary barbel reaching beyond eye. Mandibulary barbels reaching base of pectorals or almost so. Mental barbels shorter. Maxillary teeth conic to molariform, brown, in two oval patches, each twice as broad as long. Vomerine teeth similar, in a broad crescentic patch. Mandibulary teeth molar or peg-like, in two rounded patches, tapering laterally. Nineteen gill-rakers on lower limb of first branchial arch, the free membrane of whose inner border is regular, not crenulated or thrown up into loops.

Dorsal profile slightly convex from origin of dorsal fin to eye, slightly concave from above eye to snout. Lateral line conspicuous. No axillary pore. No dendritic organ. Preanal length about $2\frac{1}{2}$ in total.

Height of dorsal fin (23 to 29 mm), 1.3 to 1.7 in head, its hind border straight, its origin much nearer base of pectorals than that of ventrals. Dorsal spine little shorter than longest rays, flexible distally, more than half depth of body. Height of anterior part of anal less than half length of head. Caudal more or less than half head.

The first visible procurrent caudal rays emerge above middle of anal from a low fat pad which begins about above the anterior fifth (or sixth in IB. 3340) of anal base.

Ventrals rounded, reaching anal, slightly less than half head. Pectorals reaching ventrals, more than three-quarters head (shorter in IB. 3340); P. spine flexible distally. Body anteriorly with slender papillae, smaller and more spaced posteriorly and over top of head.

Dark-grey to brown. Lips and lower surface whitish. Described from four specimens, 180 to 230 mm long. Australian Museum regd. Nos. IB. 3333, 3340, 3355 and 3356.

Localities: 2. (IB. 3355-6), 4 (3340) and 5 (3333).

Family Tachysuridae.

Genus **Hemipimelodus** Bleeker, 1858.

Hemipimelodus Bleeker, 1858: 28 and 236. Logotype, *Pimelodus borneensis* Bleeker, 1851, from Banjermassin, Borneo.

Pachyula Ogilby, 1898: 33. Orthotype, *Hemipimelodus crassilabris* Ramsay & Ogilby, 1886. Not *Pachyiulus* Berlese, 1883, a genus of Myriapoda.

Pachyula is considered to be a subgenus, distinguished from typical *Hemipimelodus* by having the lips thick, the upper produced posteriorly in a wide lobe; adipose dorsal fin partly in advance of anal.

Hemipimelodus velutinus Weber.

(Plate 2.)

Hemipimelodus velutinus Weber, 1908: 205-207, 210, 215 & 225. Lake Sentani and rivers of northern New Guinea. *Id.* Weber, 1913: 549, 551, 604 & 608, fig. 26. *Id.* Weber & Beaufort, 1913: 325, fig. 141. *Id.* Fowler, 1928: 62.

Hemipimelodus papillifer Herre, 1935: 390 and 1936: 441, fig. 44. Sepik River. Syn. nov.

? Hemipimelodus bernhardi Nichols, 1940: 3. Idenburg River, Dutch New Guinea. D.i,6; A.ii,17; P.i,12; V.i,5; C.13 branched rays. Head (110 mm) 3.3, depth (80) 4.5 in standard length (365). Eye (14) 3 in snout (44) or 4 in interorbital (55).

Breadth of head, 81 mm. Width of mouth-opening, 34. Height of dorsal fin, 81; of anal, 50. Postorbital, 59. Ventrals, 58 to 61 mm long. Pectoral length, 94. Depth of caudal peduncle, 27.

Snout rounded. Head covered by skin. Casque granulated. Occipital process keeled, granulated. Median fontanelle does not extend to occipital process. Eyes small, orbital margins mostly free but lower portion of left eye adnate; they are not quite lateral and are in anterior half of head. Interorbital convex. Nostrils on each side close together, separated by a valve, without barbel; both above a line connecting middle of eye and point of snout. Maxillary barbels reaching gill-opening and base of pectoral. Mandibular barbels short, the outer ones surpass gill-membranes. Mouth narrow, not reaching eye, rounded; when closed only the posterior part of the maxillary band of teeth is covered. A thick fold around lips at angles of mouth but lip not produced posteriorly. A broad patch of villiform teeth on each jaw, continued across symphysis above, but with a symphysial gap below. No incisor-like teeth. Vomer slightly roughened. No palatine teeth. Gill-membranes free from isthmus at their posterior margin, connected with it anteriolaterally. Gill-rakers about 10 on lower limb of first branchial arch.

Humeral process weakly granulated. No axillary pore. Vent between middle of ventral fins. Dorsal fin with rounded tip, its origin nearer pectorals than ventrals, its spine granular anteriorly and without posterior serration. Adipose dorsal well developed, situated above anal fin, its base subequal to that of first dorsal. Pectoral long and pointed above, excavated at middle of margin (the right pectoral fin has healed after injury and is not normal). Pectoral spine similar to dorsal spine. Ventrals long, reaching anal. Caudal forked, outer rays three times length of inner ones, lobes pointed.

Colour, in alcohol, dark-grey above. Yellowish-white on front of snout and ventral surfaces. Ventral and caudal fins with brownish tinge, anal dark-grey.

Described and figured from a gutted specimen, Australian Museum regd. No. IB. 3354, 365 mm in standard length and 1 ft 5.7 in. in total length. This is larger than specimens hitherto described so that the slight differences noted are evidently due to growth.

Locality No. 4; 23 vii, 1954.

Family Melanotaeniidae.

Genus **Rhombosoma** Regan, 1914*b*.

Rhombosoma affinis (Weber).

Rhombatractus affinis Weber, 1909: 234, pl. xi, fig. 5. Sentani Lake and Wagani River, New Guinea. Wrongly synonymised with *R. goldiei* Macleay, 1883, by later authors.

Rhombosoma sepikensis Herre, 1935: 400, and 1936: 445, fig. 47. Sepik River, New Guinea.

Rhombosoma affinis Whitley, 1938: 233 and 1939: 270 (Bulolo goldfields. Synonymy).

General characters as described by Herre (1935: 400 and 1936 445, fig. 47) but with anal origin farther back.

D.i, 4 (in one case iv) /i, 16 to 17; A.i, 20 to 22; P.i, 12 to 13. Sc. 32 to 37. Tr. 9 to 11. Predors. 14 to 16.

Head 3.4 to 3.7, depth 3 to 3.4 in standard length. Eye 3.7 to 4.1, interorbital 2.4 to 4.3 in head. Snout shorter than maxillary and generally shorter than eye-diameter. Three rows of cheek-scales. About 16 gill-rakers on lower limb of first gill-arch. Lower jaw included. Premaxillary broad and strong before snout. Cleft of mouth strongly bent. Bands of teeth extending over lips. Scale-edges crenulate. Spine of first dorsal fin much longer than that of anal. Origin of anal below posterior part of spinous dorsal or below interdorsal space. First anal spine short and stout. Pectorals shorter than head without snout.

General colour in alcohol yellowish. Back mostly brown. A dark-brown band from snout through eye to tail-base, an incomplete second brown band along the scale-row level with lower part of caudal peduncle. Fins infuscated brownish. Anterior part of dorsal fin dusky, posterior part white. Anal fin slaty, darker basally.

Described from five specimens (Australian Museum regd. Nos. IB. 3344, 3346 to 3349), 75 to 104 mm in standard length.

Locality. No. 4, 21 vii, 1954. The Australian Museum has some smaller examples from the Bulolo goldfields.

Genus **Anisocentrus** Regan, 1914*b*.

Anisocentrus campsi, sp. nov.

(Figure 1.)

D.i, 5/i, 14; A.i, 23; P.i, 13; V.i., 5. C.15 branched. Sc. 39 to hypural. Tr. 10. Predorsal 18.

Head (14 mm) 4, depth (15) 3.7 in standard length (56). Snout (4) less than eye (5) which is 2.8 in head and equal to the maxillary, interorbital, and depth of caudal peduncle (5). Length of caudal peduncle from end of anal (9 mm), length of pectoral (10) equal to head without snout.

General facies of a young melanotaeniid. Three rows of cheek-scales. Jaws subequal anteriorly or lower jaw included, upper lip terminal. Mouth rather small, its cleft straight, oblique. A single outer marginal row of teeth in each jaw. A single series of splayed, spaced, enlarged teeth around outside of lower jaw. Some teeth (not splayed) exterior to marginal row outside upper jaw. An interspace between inner and outer series of teeth of lower jaw. Vomer toothed, palatines not.

Body compressed. Scales large, regular, very slightly crenulate. Caudal peduncle longer than deep. Anterior dorsal and anal rays much longer than posterior ones. Length of pectoral shorter than or equal to that of head without snout, its lower rays very short. Origin of anal below first dorsal fin. Caudal with procurrent spines.

General colour in alcohol light yellow, with brownish edges to dorsal scales and a dusky lateral band. Eye blue. Paired fins plain, others infuscated. Anal fin light with blackish edge.

Described from the holotype (Australian Museum regd. No. IB 3337), a specimen 56 mm in standard length or 69 mm (2.7 in) overall. A smaller paratype (IB. 3342), 50 mm in standard length, shows only slight variation, as follows:—

D.i, 5/i, 13; P.i, 12. Head and depth each 3.8 in standard length. Snout (4 mm) equal to eye and interorbital, 3.2 in head; less than maxillary (4.5) which equals depth of caudal peduncle. Pectoral (8) less than head without snout (9.5).

Locality.—A small creek flowing into the middle Jimmi River (33 miles, 6° E. of N.E. of Mount Hagen airstrip; altitude 1,200 ft). New Guinea; 21 vii, 1954. Coll. E. Troughton and N. Camps.

The new species differs from the type-species and the only other one known (*Anisocentrus rubrostriatus* Regan, 1914*b*, non *Nematocentris rubrostriatus* Ramsay & Ogilby, 1886 = *A. dumasi* Weber, 1907) as keyed: A. Depth 2⅓ to 3 in standard length. Sc. 33 to 36.A.i, 18 to 21. Body and vertical fins striped or spotted . . . *A. dumasi.* AA. Depth 3.7 to 3.8 in length. Sc. 39. A.i, 23 or 24. Coloration plain with median dusky band . . . *A. campsi,* nov.

Named in honour of Mr. Norman Camps, formerly a member of the staff of the Australian Museum, who collected fishes from the Jimmi River when associated with Mr. E. Troughton.

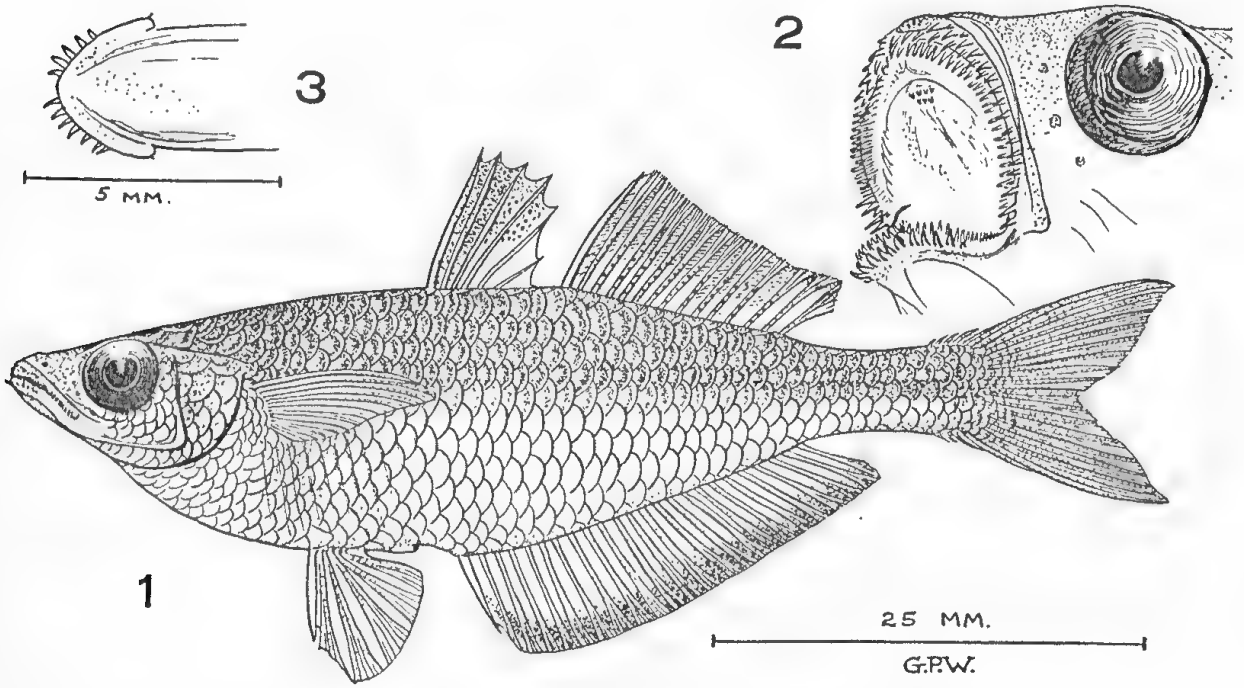


Figure 1.

Freshwater Sunfish, *Anisocentrus campsi* Whitley: 1. Holotype (Aust. Mus. regd. No. IB. 3337); 2. Dentition of paratype (IB. 3342); 3. Ventral view of lower jaw and outer teeth.

G. P. Whitley, del.

Family Teraponidae.

Genus **Terapon** Cuvier, 1816, sensu lato.

Terapon sp. juv.

Three small specimens, 16 to 28 mm long, from the Jimmi River, 1,200 ft, 33 miles N.E. of Mount Hagen airstrip, New Guinea (*Locality* No. 4), are too juvenile for satisfactory identification. An attempt was made to transport these alive by air but the fishes died.

Family Apogonidae.

Genus **Apogon** Lacépède, 1802, sensu lato.

Apogon abo Herre.

Apogon abo Herre, 1935: 402 and 1936: 447, fig. 48. Sepik (type) and Kerama Rivers.

Three (IB. 3334-5 and 3338), 39 to 105 mm. in standard length, from middle Jimmi River, 20 vii 1954. The characteristic oblique bands are faint in young specimens.

Family Gobiomoridae.

Genus **Mogurnda** Gill, 1863.

Mogurnda bloodi, sp. n.

D.vii/i, 11; A. 12; V.i, 5; Sc. 40 between head and hypural joint. Tr. 19. Predorsal 27. 13 scale-rows between dorsal and anal rays.

Head (40.5 mm) 2.8, depth (32) 3.6 in standard length (116). Eye (6) 7, interorbital (16) 2.5, snout (12) 3.3, maxillary (15) 2.7, pectoral (25) 1.6, depth of caudal peduncle (19) 2.1 in head.

Head bulbous, broad as deep. Mouth reaching below front of eye. Lower jaw projecting. Bands of coarse villiform teeth in jaws; tongue broadly rounded. Scales of top of head reach forward to level of posterior nostrils. Mucous system inconspicuous, consisting of small papillae, most discrete in a band along supraciliary grooves. Margin of preoperculum without spine, scaly. Gill-opening not reaching forward to level of eye. Scales ctenoid. Body thick, robust, compressed posteriorly. Dorsal fins well separated, longest ray equals pectoral. Dorsal and anal lobes pointed. Other fins rounded. Ventrals not reaching vent.

Colour in alcohol:—Muddy-grey to dark-brown on top of head, back and most of sides, becoming dull-cream below, the lighter colour mounting the sides in places and forming about seven pale median blotches. No conspicuous dark spots on top of head. Two indistinct brown oblique bars from the blue eye across the creamy-yellow cheek. Dark-brown blotch at hypural joint. Fins dusky-grey or brownish; superior edges of dorsal fins white; pectoral axil light cream; caudal with some dark-brown spots. Anal papilla grey.

Locality.—No. 4, 21 vii 1954.

Described from the holotype of the species (Australian Museum regd. No. IB. 3345), a specimen 116 mm in standard length or 5.8 in. overall. It is near the type-species, *M. mogurnda* (Richardson, 1844), but distinguished mainly by the high number of predorsal scales. Twenty-seven in this one, 15 to 24 in Australian *M. mogurnda* and 14 to 17 in southern Papuan examples. Named after Captain Ned B. Blood, noted New Guinea naturalist.

Differs from *M. aurifodinae* Whitley, 1938 and 1939 (types compared directly), from Bulolo goldfields, in having fewer fin-rays and more predorsal scales and in proportions.

M. variegata Nichols, 1951, of which the Australian Museum has a specimen collected by Mr. P. Hinds at the type-locality (Lake Kutubu), has more pointed head and conspicuously banded coloration; the colours of our specimen, when fresh, were as follows:

Creamy-yellow with the back and top of head dark brown. A dark-brown stripe, with irregular edges, along sides joins the back-stripe before the root of the tail. Eye bluish. Two oblique brown stripes on cheeks. Chin yellow. Fins yellow, the dorsal and caudal infuscated with greyish and the anal with dusky border. No ocelli on top of head.

Genus **Ophiocara** Gill, 1863.

Ophiocara aporos hoedtii (Bleeker).

Eleotris aporos Bleeker, 1854*a*: 59. Sindangole and Ternate.

Eleotris hoedtii Bleeker, 1854*b*: 456 and 496. Amboina.

Ophiocara aporos Koumans, 1953: 346, fig. 84 (q.v. for refs. and synon.).

One specimen, 2 inches overall (IB. 3343).

Locality No. 4.

Ground colour in alcohol white to pale yellow overlaid with dark greyish-brown at edges of dorsal scales, like a network. A brown lateral stripe, darkest posteriorly, ends in a black blotch on caudal rays. Head dusky brown above, white below with black spots. Fins dusky brown (except basal halves of ventrals and anal which are white); caudal with dark spots. Eye blue.

Family Gobiidae.

Genus **Glossogobius** Gill, 1862.

Glossogobius brunnoides (Nichols).

Gobius (*Glossogobius*) *brunnoides* Nichols, 1951; 6, fig. 4. Nondugl, Wahgi Valley.

Ground colour yellowish, plain on ventral surface, and on pectoral base and axil, but elsewhere densely overlain with brown or dark-brown markings. Sides of head with dark-brown spots some of which coalesce on the cheeks to form discontinuous longitudinal bands passing between rows of mucus-pores. Top of head dusky. Edges of most scales brown. A series of ill-defined cross-bars on body passing through a median row of conspicuous dark blotches on each side; the last blotch forms a blackish mark at root of caudal fin. Eye dull blue. Fins all dusky brown, the anal lighter proximally. An indistinct dark-grey mark near base of upper pectoral rays. Both dorsals and the caudal fin with conspicuous dark spots. One or two black blotches on posterior membranes of first dorsal fin notably conspicuous.

Three specimens (IB. 3336, 3339 and 3341), 86, 91 and 88 mm in standard length respectively.

Locality.—No. 4, 21 vii 1954.

Agree well with Nichols' description of *brunnoides*, differing only in having maxillary reaching front instead of middle of eye; narrower interorbital and slightly shorter caudal. Differs from *G. gutum* (H. Buch.) in having more dorsal rays.

Summary.

Freshwater fishes collected by members of the Australian Museum staff in the interior of New Guinea are catalogued, one *Anisocentrus* and one *Mogurnda* being described as new species. References supply a bibliography of the freshwater fishes of Papua-New Guinea.

References.

Bleeker, P. 1854*a*. Bijdrage tot de kennis der ichthyologische fauna van Halmaheira (Gilolo.) *Nat. Tijdschr. Ned. Ind.* 6: 49-62.

———— 1854*b*. Vijfde bijdrage tot de kennis der ichthyologische fauna van Amboina. *Nat. Tijdschr. Ned. Ind.* 6: 455-508.

———— 1858. De visschen van den Indischen Archipel. Siluri. *Act. Soc. Sci. Indo-Neerl.* 4: Ichth. Arch. Ind. Prodromus 1 (Batavia: Lange & Co.).

———— 1878. Quatrième mémoire sur la faune ichthyologique de la Nouvelle-Guinée. *Arch. Neerl. Sci. Nat.* Harlem 13: 35-66, pls. 2-3.

Böhlke, J. 1953. A catalogue of the type specimens of recent fishes in the Natural History Museum of Stanford University. *Stanford Ichth. Bull.* 5: 1-168.

Boulenger, G. A. 1903. Description of a new fish of the gobioid genus *Rhiacichthys* from British New Guinea. *Proc. Zool. Soc. Lond.* 1903, 2: 124, pl. 11.

Conroy, W. 1948. Fish Culture. A potential source of high-grade protein for Papua-New Guinea. *South Pacific* 2, 11: 231-233 (Aug.).

Ege, V. 1939. A Revision of the Genus *Anguilla* Shaw. *Dana Rept.* 16: 1-256, pls. 1-6, text-figs. 1-53.

Fowler, H. W. 1928. The Fishes of Oceania. *Mem. Bern. Bish. Mus.* 10: 1-540, pls. 1-49, text-figs. 1-82.

———— 1931. The Fishes of Oceania. Supplement 1. *Mem. Bern. Bish. Mus.* 11: 318-381, 7 figs.

———— 1934. The Fishes of Oceania. Supplement 2. *Mem. Bern. Bish. Mus.* 11: 383-466, figs. 1-4.

———— 1940. Zoological Results of the Denison-Crockett South Pacific Expedition. The Fishes. *Proc. Acad. Nat. Sci. Philad.* 91: 77-96, fig. 1.

———— 1949. The Fishes of Oceania. Supplement 3. *Mem. Bern. Bish. Mus.* 12: 3-152.

Fraser-Brunner, A. 1954. A synopsis of the Centropomid fishes. *Bull. Raffles Mus. Singapore.* 25: 185-213, figs. 1-4.

Grey, M. 1947. Catalogue of Type Specimens of Fishes in Chicago Natural History Museum. *Fieldiana*: Zoology 32 (3): 109-205, figs. 31-54.

Hardenberg, J. D. F. 1936. Some new or rare fishes of the Indo-Australian Archipelago. *Treubia* 15: 367-378.

———— 1941. Fishes of New Guinea. *Treubia* 18: 217-231, figs. 1-4.

Hase, A. 1914. Die Fische der Deutschen Grenzexpedition 1910 in das Kaiser-Wilhelms Land, Neu Guinea. *Jena. Zeitschr. Naturw.* 51: 525-548, figs. 1-16.

Herre, A. W. 1935. New Fishes obtained by the Crane Pacific Expedition. *Field Mus. Publ. 335 Zool. Ser.* 18: 383-438, figs. 31-33.

———— 1936. Fishes of the Crane Pacific Expedition. *Field Mus. Publ. 353, Zool. Ser.* 21: 1-472, figs. 1-50.

Jespersen, P. 1942. Indo-Pacific Leptocephalids of the Genus *Anguilla*. *Dana Rept.* 22: 1-128, pls. 1-4, text-figs. 1-83.

Koumans, F. P. 1935-7. Notes on Gobioid Fishes. *Zool. Meded.* 18: 121-150; 19: 128-134; 20: 11-26.

———— 1940. Results of a reexamination of types and specimens of Gobioid fishes. *Zool. Meded.* 22: 121-210.

———— 1949. Zoological Results of the Dutch New Guinea Expedition, 1939, No. II. The Fishes. *Nova Guinea* (n.s.) 5: 284-288.

———— 1953. Gobioidea. *Fish. Indo-Austr. Archip.* (Weber & Beaufort) 10 (Leiden: E. J. Brill).

Macleay, W. S. 1883. Contribution to a knowledge of the fishes of New Guinea, No. 4. *Proc. Linn. Soc. N.S.W.* 8: 252-280, 2 text-figs.

Nichols, J. T. 1937. Results of the Archbold Expeditions. No. 15. A new fish of the genus *Bostrychus* from New Guinea. *Amer. Mus. Novit.* 922: 1-2, fig. 1.

———— 1940. Results of the Archbold Expeditions. No. 30. New Catfishes from northern New Guinea. *Amer. Mus. Novit.* 1093: 1-3.

———— 1951. Four new gobies from New Guinea. *Amer. Mus. Novit.* 1539: 1-8, figs. 1-4.

———— 1954. A new blenny from Bali and a new threadfin from New Guinea. *Amer. Mus. Novit.* 1680: 1-5, figs. 1-3.

———— 1955. Results of the Archbold Expeditions. No. 71. Two new freshwater fishes from New Guinea. *Amer. Mus. Novit.* 1735: 1-6, figs. 1-2.

Nichols, J. T., and H. C. Raven. 1934. Two new freshwater fishes (Percesoces) from New Guinea. *Amer. Mus. Novit.* 755: 1-4, figs. 1-3.

Norman, J. R. 1935. A new percoid fish from Papua. *Copeia* 1935, 2: 61-63, fig. 1.

Ogilby, J. D. 1898. New genera and species of fishes. *Proc. Linn. Soc. N.S.W.* 23: 32-41.

Perugia, A. 1895. Viaggio di Lamberto Loria nella Papuasia orientale xiii. Pesci d'acqua dolce. *Ann. Mus. Civico Genova* (2) 14: 546-553.

Ramsay, E. P., and J. D. Ogilby. 1886. A contribution to the knowledge of the fish-fauna of New Guinea. *Proc. Linn. Soc. N.S.W.* (2) 1: 8-20.

Rapson, A. M. 1953. Resources of the Territory of Papua and New Guinea 1: 1-7.

———— 1955. Fishery investigations in Papua and New Guinea. *South Pacif. Comm. quart. Bull.* 5 (3): 20 and 24.

Regan, C. T. 1908. Descriptions of Four new freshwater fishes from British New Guinea. *Ann. Mag. Nat. Hist.* (8) 1: 153-156.

———— 1914*a*. Note on *Aristeus goldiei* Macleay, and on some other Fishes from New Guinea. *Proc. Zool. Soc. Lond.* 1914: 339-340, figs. 1-2.

———— 1914*b*. Report on the Freshwater Fishes collected in Dutch New Guinea. *Trans. Zool. Soc. Lond.* 20: 275-284, pl. 31.

Schultz, L. P. 1945. A new genus and two new species of Percoid fishes from New Guinea, Family Centropomidae. *Proc. U.S. Nat. Mus.* 96: 115-121, figs. 3-4.

Schuster, W. H. 1951. A Survey of the Inland Fisheries of the Territory of New Guinea and Papua. *Aust. J. Mar. f.w. Res.* 2: 226-236, pls. 1-11.

Simpson, C. 1954. *Adam in Plumes.* (Sydney: Angus & Robertson.) [Good historical and general account of the locale.]

Trewavas, E. 1940. New Papuan Fishes. *Ann. Mag. Nat. Hist.* (11) 6: 284-287 and map.

Weber, M., 1906. De vischfauna van Nieuw-Guinea. *K. Akad. Wet. Amsterdam, Verslag Gewone Vergad. Wis. Nat. Afdeel.* Nov. 24, 1906 (publ. Dec.): 368-372.

———— 1907. On the fresh-water fish fauna of New Guinea. *Kon. Akad Wet. Amsterdam.* December, 1906: 462-465.

———— 1908. Süsswasserfische von Neu-Guinea. *Nova Guinea* 5, Zool. 2: 201-266, pls. 11-13.

———— 1911. Die Fische der Aru und Kei-Inseln. *Abh. Senckenb. Nat. Ges.* 34: 1-49, pls. 1-2, text-figs. 1-11.

———— 1913. Süsswasserfische aus neiderlandisch Süd- und Nord- Neu-Guinea. *Nova Guinea* 9, Zool. 4: 513-613, pls. 12-14, text-figs. 1-36.

Weber, M., and L. F. de Beaufort. 1911-53. *Fishes of the Indo-Aust. Archipelago,* 1-10. (Leiden: E. J. Brill).

Whitley, G. P. 1935*a*. The Sunfish Problem. *Austr. Aquatic Life* 1: 36-37 and fig. [*Amneris rubrostriata.*]

———— 1935*b*. Fishes from Princess Charlotte Bay, North Queensland. *Rec. S. Aust. Mus.* 5: 345-365, figs. 1-11.

———— 1936. More ichthyological miscellanea. *Mem. Qld. Mus.* 11: 23-51, pl. 4, text-figs. 1-6.

———— 1938. Descriptions of some New Guinea Fishes. *Rec. Aust. Mus.* 20: 223-233, fig. 1.

———— 1939. Studies in Ichthyology. No. 12. *Rec. Aust. Mus.* 20: 264-277, figs. 1-3.

———— 1941. Ichthyological Notes and Illustrations. *Austr. Zool.* 10: 1-50, pls. 1-2, text-figs. 1-32.

———— 1943. The Fishes of New Guinea. *Aust. Mus. Mag.* 8: 141-144, 5 figs.

———— 1949. "Fish Doctor" in Papua. *Aust. Mus. Mag.* 9: 340-347, 13 figs.

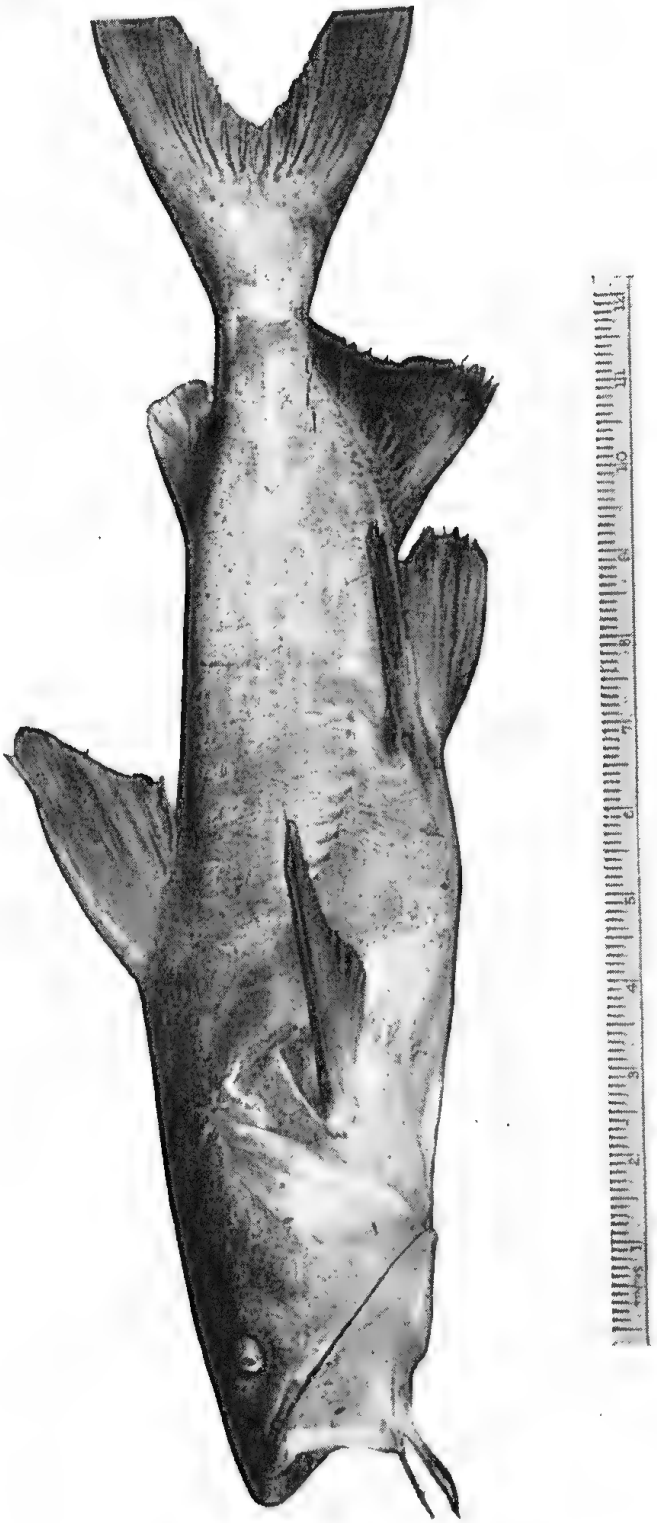
———— 1956. A New Catfish from New Guinea. *Proc. Roy. Zool. Soc. N. S. Wales* 1954-55: 44 and 68, fig. 4.

Explanation of Plate 2.

The Jimmi River Catfish, *Hemipimelodus velutinus* Weber. (Aust. Mus. regd. No. IB. 3352.) Ends of caudal lobes omitted.

Photo.—Ederic Slater.

Sydney: A. H. Pettifer, Government Printer—1956.



ADDITIONAL REMARKS ON AUSTRALIAN GYRINIDAE

By Georg Ochs,
Hanover

Through the kindness of Mr. A. N. Burns, to whom I wish to express my appreciation, I had the opportunity of examining the Gyrinidae of the National Museum of Victoria. The study of this interesting material led to the discovery of a remarkable new species of the genus *Macrogyrus* from Central Australia, which will be described. Moreover, I am enabled to give a detailed description of the nearly legendary *Macrogyrus venator* Boisd., which was represented in the collection by several specimens from Wessel Island, proving its affinity with the Australian fauna and removing the doubts alleged heretofore. Besides new records concerning already known species, I am adding remarks supplementary to my paper on Australian Gyrinidae published in 1949 (Rec. Aust. Mus. 22 (2); 171-199).

Gyrinus convexiusculus Macleay.

New South Wales: (ex coll. C. French); Croydon Park (H. Davidson); Sydney.
Northern Territory: Darwin.

Only a few examples from each locality; those from Darwin evidently smaller in size than the specimens from New South Wales.

Aulonogyrus strigosus (Fabr.).

Victoria: near Melbourne, Eltham 2.ii.1918 (H. Pottinger, F. E. Wilson); Merrie Creek 2.iv.1925 (Frauckner, ex coll. J. G. Dixon);
Bacchus Marsh 18.viii.1954 (A. Neboiss); Parwan 20.i.1916 (J. G. Dixon); Fernshaw; Western District;
Melton 15.ix.1918 (C. E. Cole); Warburton; Healesville 14.i.1918 (R. T. Kelly).
New South Wales: Sydney (J. J. Walker), Manar?
Queensland: Brisbane.
Northern Territory: Alexandria 26.vi.1903 (Billinghurst).
South Australia:

This species has been recently recorded by Dr. Brinck from Norfolk Island.

Macrogyrus darlingtoni Ochs.

Queensland: Cairns district (A. M. Lea).

Macrogyrus oblongus oblongus (Boisd.).

New South Wales: Sydney, June 1917 (G. H. Hardy), 31.iii.1918 (C. E. Cole); Narrabeen, December 1945 (B. B. Given); Blue Mountains, October 1901.

Macrogyrus oblongus opacior Blackb.

(Mentioned erroneously as *M. oblongus latior* on page 182, line 1 of my paper of 1949.)

Victoria: Mt. Macedon 1.iii.1893; near Melbourne; Plenty River; Mordialloc (a specimen of the latter series holds an anterior leg of *Dineutus neohollandicus* ♂ between its mandibles); East Gippsland, Brodribb River, 30.iv.1919; North Gippsland (H. W. Davey).

The small series from Mt. Macedon contains five specimens, one of which is labelled *M. opacior* Blackburn, from which I believe that they may be regarded as paratypes. Although not rufinotic as the types of Blackburn, some of the specimens are strongly dulled, but the interior longitudinal striae on the elytra are still visible and the striolae are normal. As a rule the apices of the elytra are more strongly sinuate than in *M. oblongus oblongus*, but less deeply so than in *M. rivularis*. The anterior tibiae are horizontally truncate in the female with the outer apical angle nearly rectangular; in the male the apex is obliquely cut off, the outer angle obtuse and slightly acuminate. In the normal form the apex is more obliquely truncate in both sexes and the outer angle less acute. The aedeagus of the male is similar to that of the normal form.

Macrogyrus oblongus latior (Clark).

New South Wales: Richmond River.
Queensland: ex coll. C. French.

Macrogyrus rivularis (Clark).

Victoria: Mason's Falls, Kinglake 10.x.1954 (A. Neboiss); Ferny Creek, Fern Tree Gully 20.i.1936 (J. E. Dixon); Melbourne, 9.iii.1918 (C. E. Cole); Beaconsfield district (J. E. Dixon); Running Creek, Kerrie (J. E. Dixon); Dandenong Creek, Bayswater (J. E. Dixon); Snowy River, 10.iv.1947 (Nat. Mus. party); Moggs Creek, January 1940 (A. Butcher); Timboon 2.iii.1908 (Kershaw); Gippsland, December 1892; South Gippsland (ex coll. C. French); East Gippsland, Glenville (per Dr. Leach).

New South Wales: Jenolan Caves 12.i.1921 (American Museum of Natural History).

Generally more shining above than *M. oblongus* and its subspecies, inner portion of truncature more concave, truncature of the anterior tibiae with a strong depression outside near the base of tarsi.

Macrogyrus reichei (Aubé).

Victoria: near Melbourne, Merrie Creek 2.iv.1925 (Frauckner, ex coll. Dixon); Studley Park; Gunbower; Eltham 2.ii.1918 (H. Pottinger); Grampians, November 1892; Bacchus Marsh, January 1907; Parwan 29.iv.1913 (Sedgewick); Warburton; Healesville 14.i.1918 (R. T. Kelly).

New South Wales:

South Australia:

Macrogyrus angustatus Rég.

Western Australia.

Macrogyrus angustatus metallescens Ochs.

Victoria: Parwan (J. E. Dixon).

It is noticeable that at this locality *M. angustatus metallescens* and *M. australis* occur side by side.

Macrogyrus australis (Brullé).

Victoria: Parwan (J. E. Dixon); Eltham (J. E. Dixon); Grampians, November 1892; Murray River (ex coll. C. French).

New South Wales: Sydney district (J.J.W.); Seven Hills (H. Davidson); Byron Bay, September 1909 (Deane, coll. Mouchamps).

Queensland: Bowen (A. Simson); Kuranda, January 1908 (R. W. Armitage).

South Australia: Wilpena Pond (H. M. Hale, Mus. Brussels).

The specimens from Murray River are of small size and very parallel, thus resembling somewhat *M. angustatus metallescens*. Examination of male genitalia proved, however, that it differs from true *M. australis*.

Macrogyrus (Tribologyrus) **gibbosus** n. sp.

Length 11.5 mm width 6 mm—Body oval, maximum of width behind the humeral region, more attenuated anteriorly than posteriorly, upper side strongly convex, humped, convexity still stronger in the male, highest point behind the scutellum, posterior declivity slightly concave in side view. Upper surface rather dull, disc of elytra shining, olive-coloured, with blue to violet reflections, labrum and clypeus aeneous, also the margins of the eyes, the longitudinal striae on elytra and the side margin of the latter. Under surface dark, metallic, natatorial legs rufous, mesosternum and metasternum vaulted, metasternal wings in form of an equilateral triangle, anal sternite narrowly sinuate apically in the male.

Labrum transverse, slightly prominent, anterior margin convex with bright hairs, upper surface strongly reticulate with round meshes and dispersed punctures, the latter more numerous and larger anteriorly and laterally, anterior portion darkly metallic. Anterior margin of clypeus nearly horizontal, posterior furrow slightly concave, upper surface strongly reticulate, with round meshes and dispersed fine punctures.

Head strongly reticulate with round meshes, moreover strongly wrinkled laterally before the eyes, between which there are fine transverse wrinkles, vertex with a fine reticulation consisting of slightly transverse meshes, interior margin of the eyes elevated, forming a straight plication in longitudinal sense, genae strongly reticulate with round meshes and deep longitudinal wrinkles, inferior margin broadly flattened and bent upwards, nearly semi-circular in dorsal view.

Anterior margin of pronotum strongly sinuate behind the eyes, with a crenulate elevated border, middle portion slightly convex, not bordered, posterior margin nearly horizontal, moderately sinuate on both sides; sides of pronotum oblique, convergent anteriorly, anterior angles protruding and pointed, posterior angles slightly prominent, rounded, lateral margin

flattened, broader anteriorly than posteriorly, with raised borders; upper surface with irregular fine wrinkles and dispersed shallow punctures, reticulation consisting of round meshes, more strongly impressed laterally than on the disc. Scutellum triangular, microsculpture consisting of round meshes. Reticulation on elytra more strongly impressed laterally than on the disc, lateral margin and longitudinal striae with round meshes, intervals and disc with elongate transverse meshes, slightly obliquely placed on the outer intervals; the meshes are accompanied by dispersed short scratches. Elytra exteriorly with three opaque longitudinal striae, the outer ones of which reach the epipleural angle; the innermost somewhat longer, narrower and separate, middle and outer striae united posteriorly, the latter joining the lateral margin basally, 4th striae very short and narrow, the inner ones hardly recognizable; outer intervals 1-3 convex, in the female more strongly so than in the male. Side margins of elytra flattened with raised borders, the broadest at the middle of length and posteriorly, where it joins an apical depression along the truncature. Inner portion of the latter horizontal and slightly concave, outer portion oblique and rather straight; epipleural angle shortly dentate, median angle in the male obtusangular, more acuminate in the female, sutural angles diminishing, slightly prominent and pointed.

Anterior femora only slightly attenuated apically, anterior tibiae short, straight, gradually broadened to apex, much broader in the male, horizontally truncate apically, exterior apical angle slightly prominent exteriorly, acuminate. Anterior tarsi of the female long, narrow, slightly attenuated towards the apex; those of the male shorter and dilated, but narrower than the tibiae, sub-parallel basally (segments 1-3) attenuated apically; underside of tarsi covered with suckers, the latter forming a round area basally comprising segment 1 and partly segment 2, ultimate segment smooth. Aedeagus as long as the lateral lobes, broader than the apical portion of the latter, basal portion subparallel, gradually narrowed in apical third, apex narrowly rounded, apical third depressed, upper side basally with a shallow groove; lateral lobes dilated in apical third, apex obliquely truncate, angles rounded.

Habitat: Central Australia, Talipatta Gorge 18.vii.1947 (C. W. Brazenor).

Holotype ♂ and allotype ♀ in the collection of the National Museum of Victoria, Melbourne.

Very near to *M. australis* which it resembles in many characters, the new species is, however, evidently larger and much more convex. In comparison with that of *M. australis*, the aedeagus of the male of the new species is longer, with the basal groove shorter and much more shallow.

Macrogyrus (Tribologyrus) **venator** (Boisduval).

Gyrinus venator Boisd. 1835, Fn. ent. Ocean pacif., Voy. *Astrolabe* 2:52.

Gyrinus venator Aubé 1838, Spec. Col. 6: 662.

Macrogyrus venator Régimbart 1882, Ann. Soc. ent. France (6) 2: 443, t.12 f.58, 58a.

Macrogyrus venator Régimbart 1884, Ann. Soc. ent. France 1883, (6) 3: 471.

Gyrinus venator Masters 1885, Proc. Linn. Soc. N.S. Wales 10: 598.

Macrogyrus venator Severin 1889, Ann. Soc. ent. Belg. 33: 158.

Macrogyrus venator Régimbart 1892, Ann. Soc. ent. France 1891, 60: 670, 740.

Macrogyrus venator Masters, 1896, Proc. Linn. Soc. N.S. Wales 21 (Supp.): 52 [698].

Macrogyrus venator Régimbart 1907, Ann. Soc. ent. France 76: 139.

Macrogyrus venator Ahlwarth 1910, Col. Cat. 21: 12.

Macrogyrus venator Mjöberg 1916, Ark. Zool. 10: 9.

Macrogyrus venator Ochs 1934, Mitt. schweiz. ent. Ges. 16: 101.

Macrogyrus (Tribologyrus) *venator* Ochs 1949, Rec. Aust. Mus. 22: 177.

Boisduval mentioned "New Holland" as the habitat of his *Gyrinus venator* and later authors recorded the species as living in Australia, apparently always in relation to the typical series. *M. venator* has almost no affinity with any other Australian species, and as it never appeared again in collections revised by me I had some doubts about its Australian origin, until, in the material communicated to me by the National Museum of Victoria, I sighted a small series from Wessel Island (C. Barrett, ex coll. F. E. Wilson), where the species seems to be confined. (The Wessel Islands are a small archipelago situated off the NE-corner of Arnhem Land, Northern Australia.) From these specimens I took the following description:

Size: ♂, 10-11.5 mm; ♀, 9.5-11 mm. Body oval, more evidently attenuated towards the apex in the female than in the male, strongly convex, maximum of convexity shortly behind the scutellum, anterior declivity convex, posterior declivity rather straight, beneath, strongly vaulted along median line. Upper surface shining, dull exteriorly, olive-green with violet to coppery reflections, vertex darker.

Labrum, clypeus and margins of the eyes brighter coloured, also the longitudinal striae on elytra and the side-margin of the latter; scutellum brassy. Under surface black, natatorial legs reddish, metasternal wings in the form of a nearly equilateral triangle, apical sternite in the male truncate apically, and slightly concave. Labrum transverse, slightly prominent, anterior margin convex with bright hairs, upper surface with strongly impressed round meshes and dispersed punctures. Microsculpture of clypeus nearly granulate, medially superficial with slightly elongate transverse meshes, punctures chiefly confined to the vicinity of the posterior margin, the latter and the anterior margin concave.

Head with irregular strong wrinkles, microsculpture consisting chiefly of round meshes, more transverse anteriorly in the middle, vertex with irregular elongate meshes, anterior portion of the head finely punctured between the eyes, with two shallow impressions; interior border of the eyes slightly acuminate, genae strongly sculptured, with round meshes and longitudinal wrinkles, under margin broadly flattened, elevately bordered.

Anterior margin of pronotum moderately sinuate and edged behind the eyes, medially nearly horizontal, not bordered, posterior margin nearly horizontal, side margins oblique, convergent anteriorly, narrowly flattened and with raised edges, anterior angle strongly protruding; upper surface of pronotum irregularly wrinkled, reticulate, round meshes more strongly impressed laterally than on the disc, the latter finely punctured, near the base there is a roundish impression showing a fine reticulation of transverse meshes. Scutellum triangular, covered with round meshes.

Elytra with strongly impressed round meshes on the sides, disc with superficial meshes and fine punctures, meshes somewhat elongate and transverse towards the apex near the suture, scratches scarcely visible in apical half. Elytra laterally with three shallow opaque longitudinal striae reaching nearly to the epipleural angle, the innermost one of which is narrow and separate, the median stria joins the outer one at the base and unites with it apically, the outer stria is joined to the side margin at the humeral region, inner striae visible only as meandering lines, all intervals even, the inner ones covered with dispersed transverse fine wrinkles. Side margin of elytra flattened and with raised edges, narrow at the base, broadened and nearly parallel posteriorly, inner portion of truncature horizontal, outer portion oblique, epipleural angle shortly dentate, median angle triangular, sutural angles diminishing, slightly prominent.

Anterior femora more strongly attenuated apically in the male than in the female. Anterior tibiae curved inwards and broadened towards the apex, more noticeably so in the male, exterior apical angle slightly prominent. Anterior tarsi subparallel and slightly attenuated towards the apex in the female, but moderately broadened in the male and narrower than the apex of the tibiae, underside covered with suckers, forming a rounded area on segment 1, the base of the latter smooth. Aedeagus robust, flat, shorter and broader than the lateral lobes, basal portion subparallel, apical third gradually attenuated, tip rounded (in a ♂ of small size the apex is more broadly truncate), based two-thirds of the upper side superficially channelled, underside with a deep broad longitudinal furrow reaching nearly to the apex; lateral lobes moderately broadened towards the apex, the latter rounded.

Probably there are some related species to the group of *M. blanchardi* from New Guinea with regard to the shape of the anterior tibiae.

Macrogyrus elongatus laevis Ochs.

Queensland: Claudie River, January 1914 (T.A.K.).

Macrogyrus howitti (Clark).

Victoria: Eltham.

Queensland: ex coll. C. French.

Tasmania: Hobart 22.i.1918 (C. E. Cole); Georgetown, March 1895; Georgetown (ex coll. Plason, Mus. Vienna).

In some of the specimens the internal striae on the elytra are more evident than normally and the intervals more convex; in the specimens from Georgetown the middle of the truncature is slightly angular.

Macrogyrus striolatus (Guérin).

New South Wales: Chichester, Blue Gum Knob; Leura 1910 (Deane).

In the males of this species there exists a very remarkable sexual character, the prosternum being anteriorly broadly expanded and transversely truncate, with the exterior angles of the truncature acuminate and slightly bent downwards.

Dineutus australis (Fabricius).

Queensland: Cairns (ex coll. C. French); N. Queensland (identified by A. M. Lea).
Central Australia: Coll. Horn Exp., pres. July 1897 (Finke).
North Australia: Darwin (G. F. Hill).

Dineutus neohollandicus Ochs.

Queensland.

As mentioned above, a specimen of *M. oblongus opacior* from Mordialloc holds an anterior leg of *D. neohollandicus* ♂ in its mandibles, which seems to prove that the latter species occurs also in Victoria. Hitherto it was chiefly known from Northern Australia and from Queensland, but in the Dresden Museum there is a specimen which is labelled "Victoria", a record which formerly seemed doubtful.

A detailed description of *D. neohollandicus*, accompanied by several figures, is given by Dr. Mouchamps in 1949 (*Bull. Ann. Soc. ent. Belg.* 85: 241, pl.2, f.3; pl.3, f.2; pl.4, f.9). Having had the opportunity of studying one of the specimens from Adelaide River, in the British Museum, mentioned by Régimbart as *D. neoguineensis* in 1907, Mouchamps states that it differs from *D. neohollandicus* which confirms my opinion that in Australia the latter species only, occurs.

The zoogeography of *D. neohollandicus* and other Australian species is discussed by Dr. Brinck in 1952 (*Lunds Univ. Arsskr.*, N.F. Avd. 2, 49: 3-6). His opinions in the matter are very contrary to those expressed in my paper of 1949 but not convincing in all respects.

Sydney: A. H. Pettifer, Government Printer—1956.

ROCK ENGRAVINGS OF THE SYDNEY-HAWKESBURY DISTRICT

Pt. 1: Flat Rocks Ridge: a Daruk Ceremonial Ground.

By FREDERICK D. McCARTHY

Attention was first drawn to the Flat Rocks gallery by the late R. H. Mathews, who illustrated nine of the figures in various papers between 1895 and 1899. He visited the site (Group 6) during his work as a surveyor and had it reserved as a national monument. In 1945 Mr. Gordon Boes gave me the localities of Groups 1 to 5 on the same ridge, which runs from the south-west to the north-east for about ten miles, extending from Gunderman, on the Hawkesbury River, to Mangrove Creek. I first visited Flat Rocks in 1947 with Mr. Paddy Pallin, and in the same year I spent a week recording Groups 1 to 7, in the area between Starkey Trigonometrical Station and Flat Rocks, accompanied by Mr. R. Gavin, a Museum preparator. I spent a week in early April, 1954, accompanied by another preparator, Mr. N. Camps, recording Groups 8 to 13 which are situated east of Flat Rocks and on a ridge some distance away.

Flat Rocks ridge is situated in typical Hawkesbury sandstone country covered with eucalypt open forest or woodland. The undergrowth is patchy on the ridges but is often thick and spiky in the gorge and valley bottoms. On the ridges the terrain is rough, being covered with broken rocks and large outcrops of sandstone. The trees push up rings of rocks at their base as they develop to maturity, and when the trees are burnt out by a bush fire these rings of stones suggest artificial arrangements.

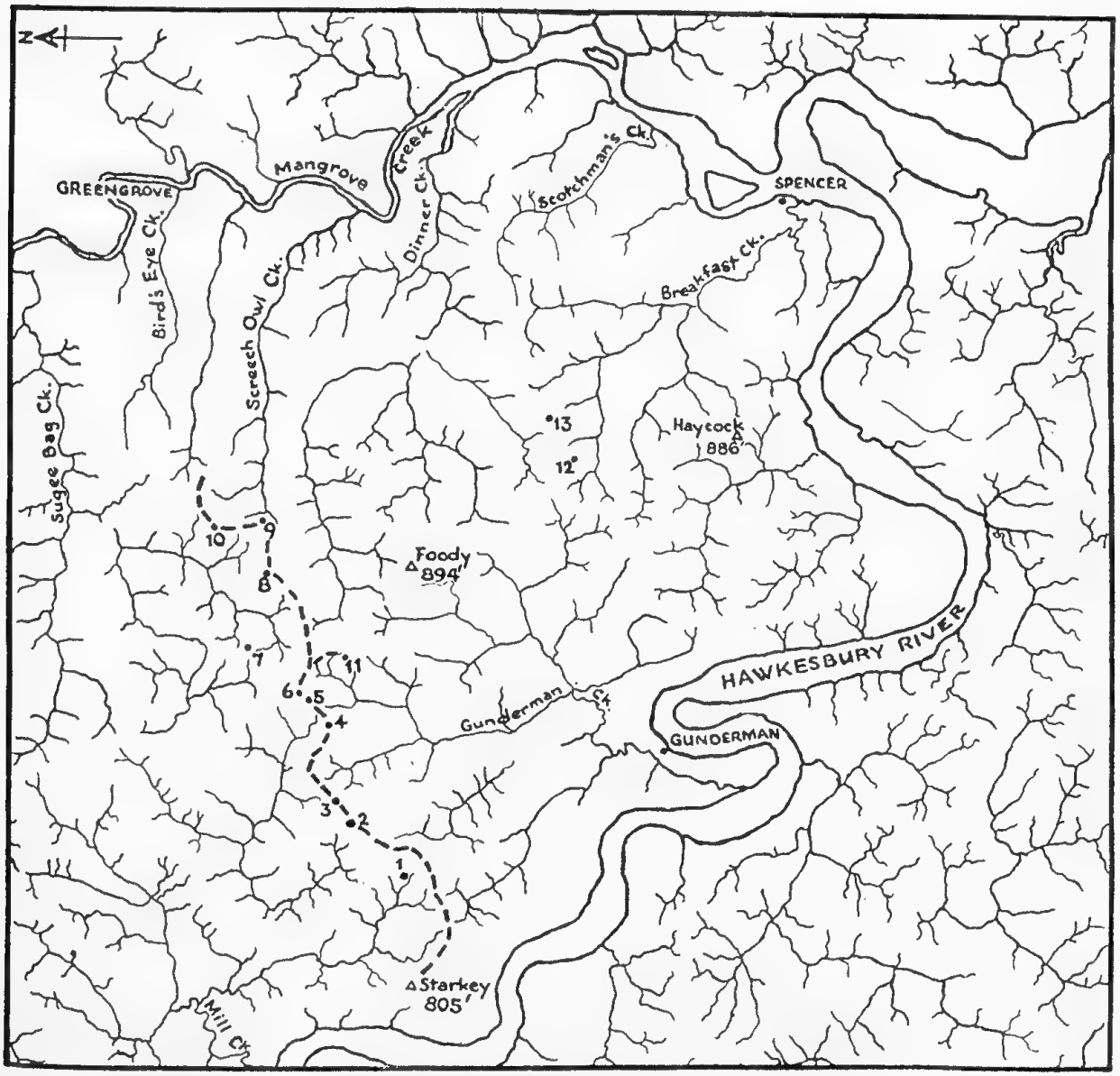


Fig. 1.—Flat Rocks Ridge area, showing location of Groups 1 to 13.

*88732—1

Represented in the engravings are mammals which still frequent the area—rock wallabies (fairly common), and wombats, echidnas, and possums, which occur in reasonable numbers. Others are rare or extinct. An occasional Great Grey kangaroo and dingo may be seen. Emus are extinct although featured in several galleries. Flying foxes still haunt the countryside and feed on Angophora blossoms in late summer and early autumn. The area lies within the territory of the Daruk tribe.

There are in all nine groups (Nos. 1 to 6, 8 to 10) of rock engravings on the Flat Rocks ridge, and these will be described from the Starkey Trig. or southern end. There is, in addition, one group (No. 7) on a ridge (adjoining the Flat Rocks site) which forms the eastern side of Dinner Creek. This group is at the Flat Rocks end of the ridge; a reconnaissance of this and another ridge running north-westward towards Mill Creek did not reveal any carvings. Three further groups (Nos. 11 to 13) occur on the ridge running from Flat Rocks through Foody Trig. Station and thence to Mangrove Creek at Scotchman's Creek. The whole of this section of country is a maze of steep sided ridges, deep gorges, and creeks. Mill and Gunderman creeks flow into the Hawkesbury river, while Breakfast, Scotchman's, Dinner, Screech Owl, Bird's Eye and Sugee Bag Creeks flow into Mangrove Creek, a major tributary of the Hawkesbury river.

FLAT ROCKS RIDGE

Group 1.

This group is situated on top of the ridge at military map reading 057.705, and the figures are engraved on a number of separate rocks. The group is about a mile east of Starkey Trig. Station, at the head of a small creek joining part of the headwaters of a larger creek which flows into the Hawkesbury River. The rocks are surrounded by large trees and low scrub on two sides.

Series I, northern end of group, Nos. 1 to 4.—In the north-western corner of the rock is (1) a beautiful pelican, 4 ft 6 in. long, with no legs, as though it is swimming, and its bill rubbed into an intaglio groove. With it is (2) an animal-like figure of indeterminate nature, and (3) a male wallaby 4 ft 6 in. long with a triangle of rubbed intaglio work on the underside of its neck, unusual single line endings to the front and hind legs, and a long, sharply pointed tail. Eight feet above these figures is (4) a crudely drawn kangaroo, 6 ft 9 in long, with a large rounded head and short tail.

Nos. 5 to 13.—East of the kangaroo (4) is another series of small figures, on the south-eastern corner of the rock, comprising: (5) two circular figures about 20 in long, one of which bears two lines like a neck running into natural cracks; (6) a headless wallaby; (7),

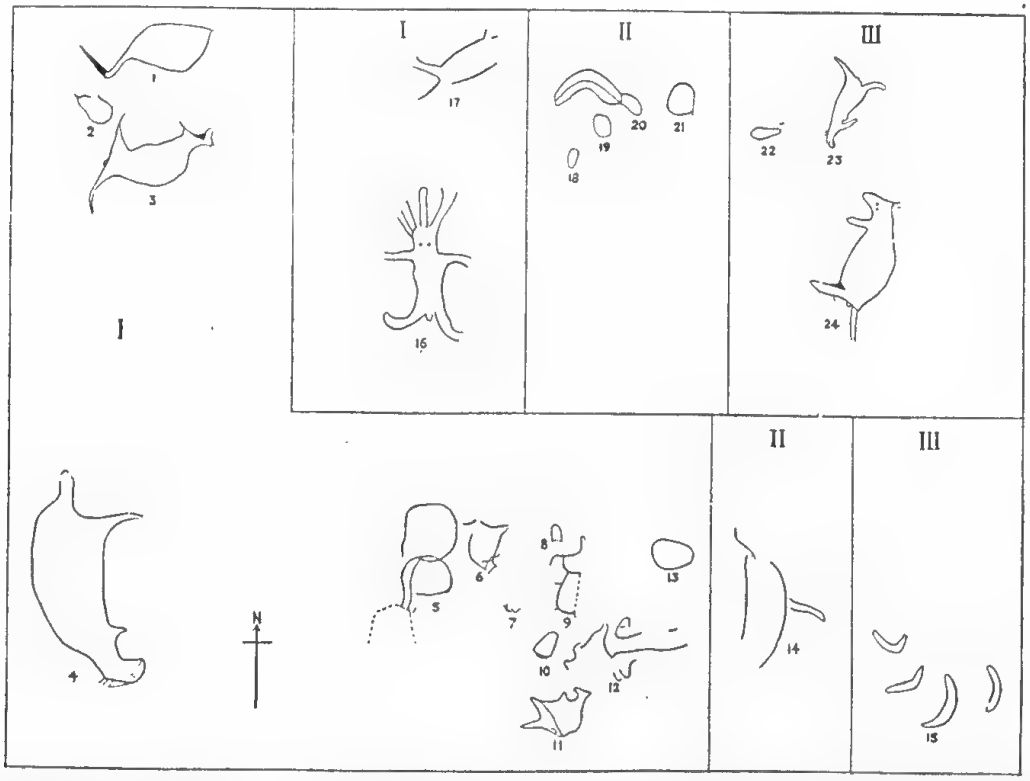


Fig. 2—Left and bottom: Group 1, Series i to iii. Top right: Group 4, Series i to iii.

(9), (12) several complicated and indeterminate line figures in two of which the punctured outline is continued in natural cracks; (8), (10) two human foot-tracks, or mundoes, with toes; (11) a wallaby just over 2 ft long with a band across its hindquarters, on which there is also a crescentic mark; (13) an oval 13½ in long.

Series II.—Thirty feet south of Series I, on another rock, is (14) an indefinite figure, incomplete and weathered away in parts, of an emu (?) just over 4 ft long.

Series III.—Just over one hundred feet to the south-east is another rock bearing (15), four returning boomerangs, two of which are angled types.

Technique and Preservation.—The figures in Series I all have conjoined punctured outlines ½ in wide and from ⅛-3/16 in deep. Many of them though not weathered to any extent are difficult to discern because the grooves have become coloured by weather and lichen in the same way as the rock surface itself. Series II and III have smooth rubbed grooves, rather faded by weathering, and would appear to be older than Series I.

Remarks.—The human foot-tracks suggest the hunting of a kangaroo (or wallaby) with boomerangs. Kangaroos (or wallabies) form the commonest motif in the group. The complex grouping of indeterminate figures in Series I is unusual, as are the intaglio bill of the pelican and a similar marking on the wallaby (3).

Group 2.

This group is situated on a large undulating rock surface at the juncture of the second spur south of Flat Rocks, on the eastern side of the latter ridge, at military map reading 065.712. The rock is on the lower edge of the spur, above the deep gorge of Mill Creek, with large trees and thick low scrub above it on the ridge.

Series I.—At the western end of the rock, where it is flat but sloping to the south, are to be seen (1) a small oval, probably a mundoe and (2) a fine male kangaroo, almost 5 ft long, in a stylized pose with drooping tail. It is twenty-five feet north of a set of five figures engraved in a concave area of rock. They consist of (3) another kangaroo 5 ft 6 in long in a stylized pose similar to (2); (4) a woman 7 ft 3 in long in an agitated dancing pose, with arms curved (fingers shown) above her head which is thrown back to one side, lateral breasts, and short legs. The three lines on her breast might represent either painted or cicatrized lines. The next one is (5) a bird like a scrub-hen, with single pointed limb, and deeply hollowed back, in a standing pose. Below this bird is (6) an excellent koala bear 6 ft 7 in long, in profile, with outstretched single arm bearing four claws, also in the typical stylized standing pose in which this mammal is usually depicted. Below its arm is (7) a leaping kangaroo over 6 ft long. The three kangaroos in this series are correctly proportioned, with thick hind-quarters and slender upper bodies.

Technique and Preservation.—The outline of No. 2 is of fresh, clearly defined conjoined punctures ¾ in wide and ⅜ in deep. The outlines of Nos. 3 to 7 are of smoothed conjoined punctures, slightly weathered but not rubbed, ¾ to 1 in wide and up to ⅜ in deep. They are all thus well defined.

Remarks.—The presence of the woman in a dancing pose indicates a ritual significance for this series. The animals are characteristic of those upon which the local Aborigines depended for food, and used as totems, particularly the kangaroo.

Series II.—On an adjoining rock surface, about sixty feet to the east, is one of the finest and most impressive pictorial compositions yet recorded among the rock engravings of the Sydney-Hawkesbury district. The rock is convex and slopes from the north to the south down the side of the ridge. It is an inspiring experience to approach this rock and see the work of an outstanding craftsman in this technique. The composition illustrates a kangaroo hunt. Towards the western end of the rock is (8) a gigantic kangaroo 16 ft 6 in long and 10 ft 3 in across the body from hind-toe to back. The tail is rather short and broad, the neck very thick, and the facial outline rounded. There are ten small basin-like pits on the head, the largest two of which might indicate eyes, but it is difficult to say whether the others are natural (as they occur elsewhere on the rock) or engraved for some purpose not understood. Four digits are shown on the front paw, and two large toes on the hind foot. The pose is stylized, semi-leaping in nature. This huge animal has been struck with twelve boomerangs from 1 to 2 ft long, some of which have the deep curve of the returning type and others the shallow curve of the non-returning boomerang. One might be a bladed throwing club. Five have hit the animal on the face, three on the neck, and one on the stomach. About twenty feet eastward are (9), (10) two dingoes, also large, being 5 ft 6 in and 6 ft long, in hot pursuit of the kangaroo, their months open and tails held up. They are well placed in the composition, and are unusually animated and unique depictions of this animal.

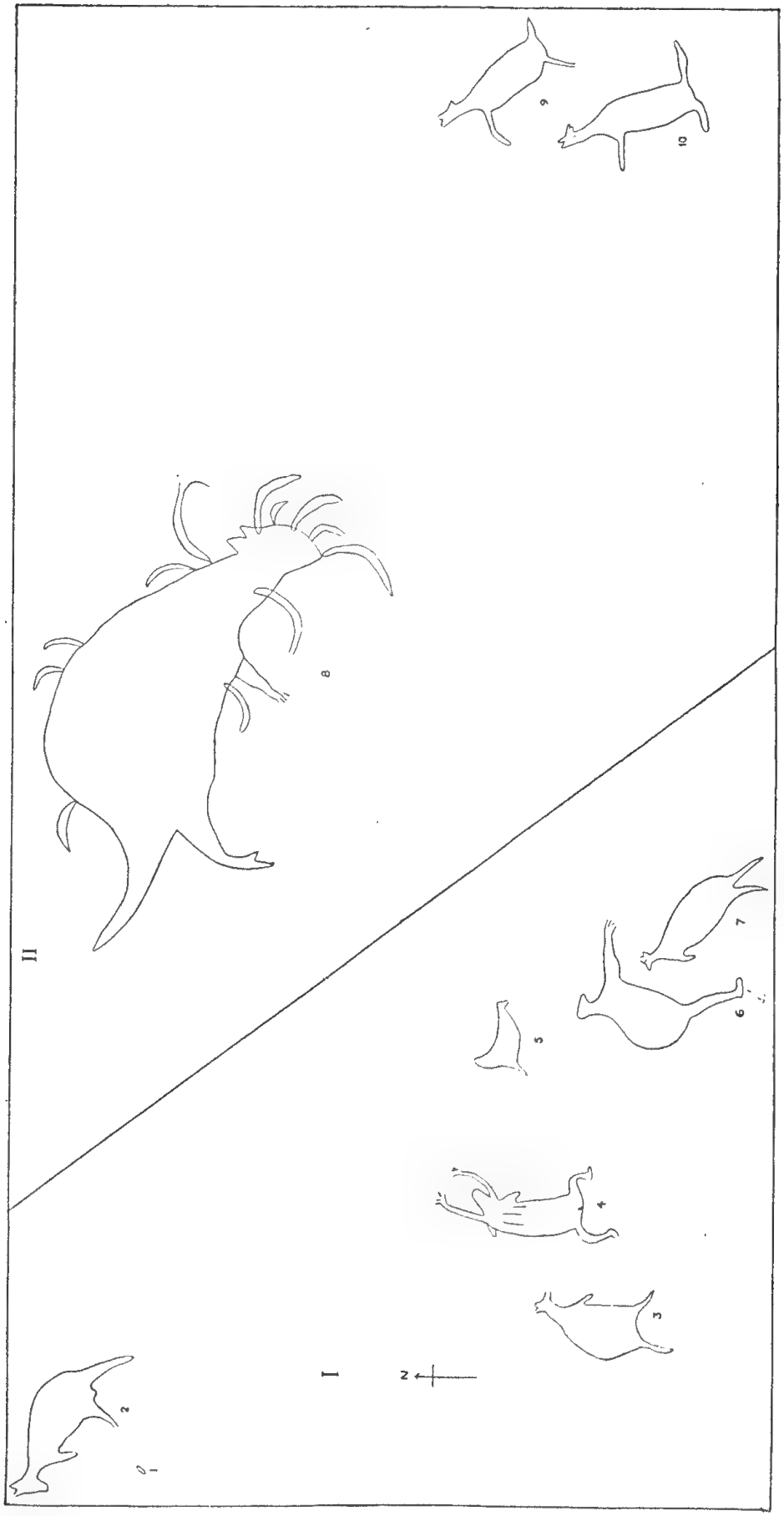


Fig. 3.—Group 2, Series I-II.

Technique and Preservation.—The kangaroo and boomerangs have rubbed grooves from 1 to 1½ in wide and up to ½ in deep, but those of the dingoes consist of conjoined punctures up to ¾ in wide and ⅜ in deep, suggesting that they are a subsequent addition to the group or that their outlines had not yet been rubbed smooth like those of the other figures.

Remarks.—This is obviously a group of gigantic dreamtime animals explained by chants and stories to initiates taken to this rock. No myth has been recorded from the Daruk tribe to explain this group, which probably represents the legendary figures of a kangaroo killed by members of the dingo totem, forming part of an historical saga connected with this ridge as a whole.

Group 3.

Group 3 is situated on a long narrow rock ledge which runs for some hundreds of yards along the northern side of a saddle about fifty feet below the top of the ridge at military map reading 068.714. The saddle is covered by large trees and scrub. From it is to be seen an extensive view into the headwaters of Mill Creek and across the ridges to the north. There are five series of engravings at this site.

Series I.—At the northern end of the ledge, on a flat but slightly sloping rock surface, is (1) a male wallaby 5 ft 3 in long, excellently proportioned and in a leaping pose with tail curved upwards, hind limb forward ready to land, forelegs pointed backwards, and head well poised on a long straight neck. It has been struck on the forehead by a small boomerang. The outlines consist of conjoined punctures up to 1 in wide and ⅜ in deep, clearly defined and well preserved, although the facial outline of the wallaby is indistinct.

Series II.—Engraved on a small flat rock among bushes, and east of Series I, is (6) a young emu 15 in long, depicted as though picking food from the ground. Its outline is made up of conjoined punctures ¾ in wide and 3/16 in deep.

Series III.—Ninety feet north-east of Series II, on a flat rock just below the top of the saddle, are engraved (2) a death-adder snake, in semi-coiled position, with tongue protruding, and (3) to (5) three barred elongate objects from 2 ft 6 in to 3 ft 9 in long, which at first sight suggest bark-canoes, but as one has ears they are probably eels or fish. The outlines of this series are ½ in wide and ⅛ in deep, all being very weathered and indistinct.

Series IV.—This is the first portion of the main part of the group as a whole. The rock ledge is divided lengthwise by a wide crack in which flowers and grass are growing. On the upper part, which begins at a point about ninety feet south of Series II, are the following figures: (1) An open oval figure 6 in long, and a short, straight line; (2) young emu, striped as on the young birds, 13 in long; (3) indeterminate animal which could be a young emu or possum. Below this series, on the main rock in the group, is (4) an emu's head. Thirty-six feet to the south of (2) is (5) a mundoe with toes; at thirty-nine feet in the same direction is (6) a wallaby, poorly designed, 2 ft long, facing in the opposite direction to the mundoes; at sixty-six feet is another (7) human foot with toes; at one hundred feet is (8) another mundoe, and above it (9) a poorly done figure of a man with bent legs and penis (which is very long) as though he is in a dancing posture, with knees pushed forward.

On the lower rock, which is concave in this section, and nine feet west of (6) is (10) the remarkable figure of a huge woman 18 ft. long. She is turned sideways with her face to the front, her footless legs are close together, her buttocks project two feet, her breasts are small and hang from the base of the arms. The latter are slightly above the horizontal, one has two large fingers, the other three, and both bear armlets on the upper arm and wrist. Her head is remarkable because of its enormous ears and five eyes, and the well-defined neck is an unusual feature of anthropomorphic figures among these engravings. Two attempts were apparently made to shape one side of the neck. Her outline is a smooth rubbed groove from 1½ to 2 in wide, and up to ½ in deep, being well defined and preserved. On one leg and below it is a series of weathered pits which might have some significance, but it is now impossible to determine whether they are artificial or natural in origin.

Series V.—On the next part of the outcrop to the south is a most interesting series of figures extending for more than one hundred feet to the southern end of the ledge. At the northern end is (11) a small triangular bag-like figure 1 ft long; below it is (12) a mundoe with toes pointing towards the female ancestral spirit and (13) a fine male wallaby 6 ft 3 in long; the surface of that part of the rock bearing the tail has flaked off. The head is held back, and the digits are shown on the forepaws. Above the wallaby is a curved line. Then come (14) two shallow potholes, which contain water during and after rain, with approximately forty axe-grinding grooves around them; (15) a circle almost 2 ft in diameter; (16) a well posed goose, 3 ft 5 in long, struck on the neck with a boomerang; (17) (18) lines

of indeterminate and incomplete figures; (19) a magnificent alert emu about 9 ft high and long, whose neck runs round the side of a small pothole. Its toes are ill defined but the bird is beautifully posed. In the next series are (20) an indeterminate and incomplete line figure; (21) two boomerangs 10 and 15 in long at the bird's head; (22) a man 6 ft 6 in high with a complicated series of lines about his head. He appears to have thrown his boomerang at the emu; (23) a set of smooth pits which probably represent a clutch of emu eggs; (24) a human leg-like figure which may be portion of a man or constitute a design in itself; (25) a pothole, now filled with soil, surrounded by about twenty axe-grinding grooves.

The next section of the rock is concave and slopes steeply down the ridge, but on it occur figures of (26) a possum 2 ft 6 in long; (27) a swordfish 14 ft long, with a small tail, four fins, five eyes, and a band across the sword; (28) a bag or incomplete bird; and (29) a roughly-shaped shield.

Technique and Preservation.—The outlines of the swordfish, possum, leg-like figure, man, large emu, human foot-track, and wallaby are smooth rubbed grooves from 1 to 2 in wide and 3/16–$\frac{3}{8}$ in deep. Those of the pelican, boomerangs and bag consist of conjoined punctures up to $\frac{3}{4}$ in wide and 3/16 in deep, and should be inspected in the early morning or late afternoon light. The shield and bag-like figure nearby display conjoined punctures 1 in wide and 3/16 in deep, and they have been smoothed by weathering.

Remarks.—Series I to III might be regarded as casual sets of engravings, but the human tracks, which are from 9 to 16 in long, indicate the sacred nature of the main group and probably represent the track of the large woman. It is probable that other figures in the group are featured in the legend connected with this female ancestress. On the other hand, there appears to be a hierarchy of figures in the group as a whole which makes it very difficult, as with other groups, to interpret them from the point of view of associations. The more important series, with the deepest and widest grooves, comprising the large woman, emu, boomerang, man, possum, swordfish, and several human tracks, might thus be considered as a ritual set. The technique also indicates that another set might consist of the circle (a pool?) the emu and the goose struck by boomerangs, the man, wallaby and human foot-track.

The woman is isolated in all her glory in the middle of a large portion of the rock surface. This woman, and the one shown in Group 6 (Series II, fig. 38) could have been the wife, shown in two different aspects, or wives, of the supreme culture-hero of this area. Thus, among the Wuradjuri of southern New South Wales (Berndt 1947: 77), the wife of Baiami was Kurikuta, an eternal ancestral being who left the earth in ancestral times to live in the sky. She was envisaged as being beautifully shaped, with large and protruding breasts, youthful and virile in nature. Her assistant-totem was the emu, and for this reason people cooking emu had to be careful not to burn the fat, otherwise Kurikuta would come down in the smoke, sending thunder in the day or a flash of lightning in the night as a warning. The lightning was produced by the movements of her body which was covered with glistening quartz crystals. A clever magician could divert Kurikuta from a camp, otherwise a number of people were killed during her visitation. In both groups of engravings (Groups 3 and 6) emus are represented, probably in the ritual relationship of assistant-totem to these female ancestral figures.

The swordfish is a unique petroglyph and its occurrence here is another indication that river people were the artists.

Group 4.

This group is situated on a series of large and prominent exposures of rock on the northern side of a very short spur jutting out into the headwaters of Gunderman Creek on the southern side of Flat Rocks ridge, and about one quarter of a mile from Flat Rocks, which can be seen from the eastern end of the outcrop. The military map reading is 078.716. Although the rock surfaces here are extensive and ideal for carvings only a few scattered figures exist.

Series I.—Engraved on a rock surface at the base of a ridge where it joins the spur, slightly south of the middle of the latter, are (16) a man 5 ft long with a rayed headband, no hands or feet; (17) portion of a wallaby. They are both faint, with outlines or conjoined punctures up to 1 in wide smoothed by weathering.

Series II.—On the next level down the slope, on the northern side of the saddle where the spur joins the main ridge, on a large rock surface, are: (18), (19) two human foot-tracks; (20) a curious crescentic figure with an oval head and a median stripe; (21) a circle 1 ft in diameter. They have smoothed grooves which have been rubbed (but are also weathered and faintly preserved) from 1 to 2 in wide and 3/16 in deep.

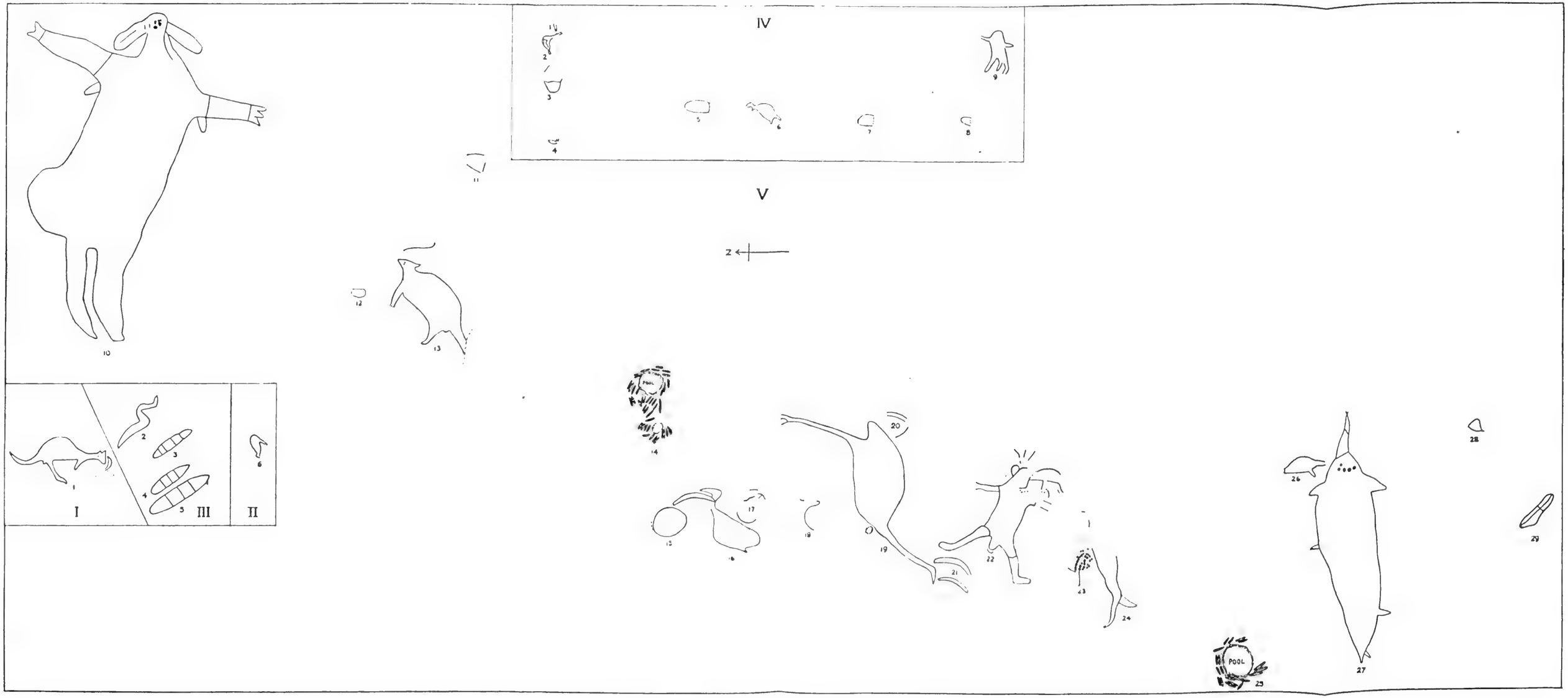


Fig. 4.—Group 3, Series I to V.

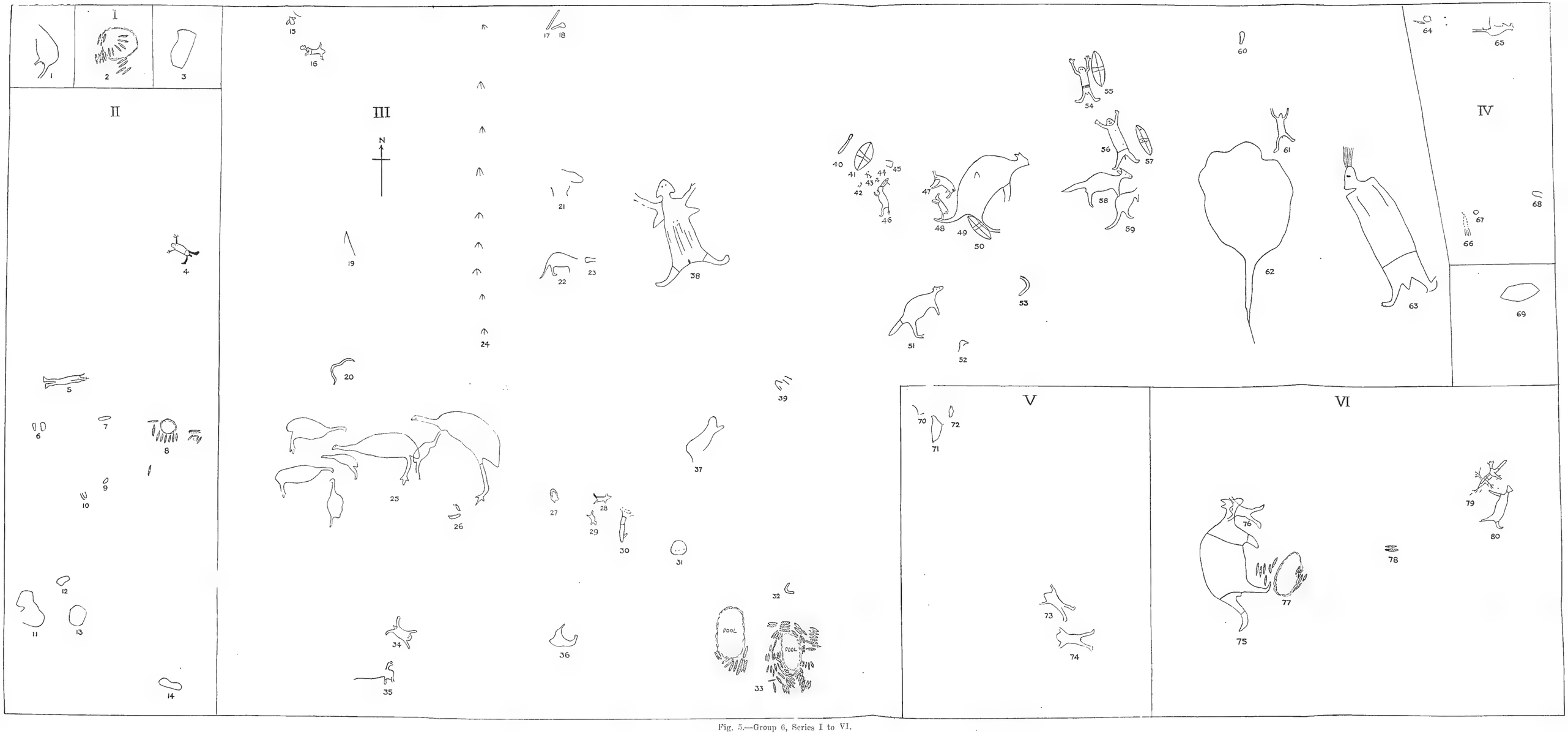


Fig. 5.—Group 6, Series I to VI.

Series III.—Situated at the end of a high ledge of rock at the eastern end of the outcrop are (22) a human foot-track; (23), (24) two wallabies, one of which, 4 ft 9 in long, is badly drawn, and has an outline of conjoined punctures up to 1 in wide and ¼ in deep. The outline of the other is similar but is from ½–¾ in wide and from ⅛–3/16 in deep. They are well preserved.

Remarks.—These sets would appear to have no special significance apart from the man wearing a ceremonial headband or head-dress. The crescentic figure is unique and indeterminate in nature, but it might represent a sword-club with a well defined handle. Most of the sets have weathered to faint outlines and the group is an old one.

Group 5.

Group 5 is located on a large expanse of rock with a rough, undulating, and pocketed surface, at the junction of a saddle and a spur about half a mile south-east of Flat Rocks, at a military map reading of 083.717. Here two mundoes were found pointing northwards, that is towards the main group, No. 6, but were not recorded. They apparently tie up the groups of carvings along this ridge and indicate the ritual path followed by the ancestral men and women, and subsequently by the living Aborigines during ceremonies. Thus another single mundoe was noted on a rock between Flat Rocks group and a group on the Foody Trig. Station ridge; no doubt it served the same purpose.

FLAT ROCKS

Group 6.

This site consists of a remarkably large rock surface, broken here and there by vegetation growing on thin layers of soil which have accumulated on various parts of the rock, and also in shallow potholes and depressions. The portion bearing the engravings is approximately 350 feet long and up to 100 feet wide, and slopes generally from north to south, where it ends in a series of steep and broken faces. The creeks on the southern side of this gallery form part of the headwaters of Gunderman creek, and those on the north are the headwaters of Mill Creek. Flat Rocks, whose military map reading is 082.720, is at a point where a number of important ridges come together from Gunderman and Starkey Trig. Station in the south and south-west, Mill Creek in the north-west, Mangrove Creek to the east by means of the Foody Trig. ridge from Scotchman's Creek, and several ridges between there and Dinner Creek. It can be reached either by following these ridges or by following up creeks such as Gunderman, Mill, Dinner, and Sugee Bag.[1] There is an extensive view into all the gorges at the headwaters of these creeks, and also across the ridges in various directions.

There are several small rock-shelters below the southern side of the main rock surface, but they show no signs of occupation. Near the lower edge of the rock is a pothole 5 x 3 ft and 2 ft deep (which holds stagnant water practically all the year round) surrounded by approximately seventy-four axe-grinding grooves. Above this pool is another pothole, filled with soil in which a sapling 10 ft high is growing, with about a dozen more grooves beside its lower edge. There is a reliable supply of water in a creek which runs down the ridge on the southern side of the gallery.

The site will be described in seven series of figures, beginning at the southern end from where is passed in review a magnificent series of engravings that must have taken many generations of artists to accomplish.

Series I.—At the extreme southern end, in a shallow depression on a large rock surface on the western side of the ridge, is (1) an incomplete headless kangaroo or wallaby 6 ft long; ninety feet north is (2) a shallow pothole (which holds water only in rainy weather), with nine axe-grinding grooves beside it and a further eight ground out on the bottom in a neat crescentic series. There is another pothole 15 in deep which holds water on this rock. One hundred yards north-east of Nos. 1 and 2 is (3) an irregular oval figure about 4 ft long with faded shallow outlines.

Series II.—This brings us to the first of the main rocks. In the south-western corner is (4) a man just over 3 ft long, with three and four long fingers, four eyes and a girdle, remarkable for the manner in which his legs, arms, and penis are hollowed out by rubbing into intaglio grooves up to 3 in wide. His outline consists of fresh conjoined punctures ¾ in wide and ¼ in deep.

A further one hundred yards in the same direction is (5) a headless man, long and slender in form, 5 ft 6 in high, with indefinite arms and head. A pair of mundoes (6) occur east of him, running from north to south, and another one (7), engraved from east to west, points to the main group. The outlines of all these figures consist of conjoined punctures up to 1 in wide and ⅛ in deep, smoothed by weathering and considerably faded.

---

[1]Along which bush walkers have erected a number of small cairns of stones as guides.

On another rock surface, near the southern end of the gallery occurs (8), two very shallow potholes holding water in rainy weather only, with eight and two axe-grinding grooves beside them.

Forty feet north-east of (7) are (9) and (10) two more mundoes, one running from the south-west to the north-east, the other from the south-east to the north-west. Both have faded outlines.

One hundred and twenty feet south of No. 4, at the edge of a flat white rock, are (12) and (13) two ovals 15 and 24 in long, and (11) a large bag-like figure which might be an animal (koala bear), 4 ft long, all close together. Their outlines are rubbed grooves from 1½ to 2 in wide and from ¼-½ in deep.

Fifty feet east of No. 5 is (14) another irregular oval figure 2 ft 4 in long, with rubbed grooves 2 in wide and ½ in deep, very well preserved.

Series III.—Along the western side of the rock is (15) a small flying-fox 10 in long, with outspread wings and a crescentic line beside it; (16) a small man almost 3 ft long wearing a girdle, with an extension of one leg which is now very faint and difficult to discern. Both of these figures have conjoined punctured outlines 1 in wide and from ⅛-3/16 in deep but smoothed by weathering.

Continuing along this western side of the rock occur (17) a straight narrow weapon 2 ft 6 in long which is probably a spearthrower, and (18) a bulbous-headed club 1 ft 6 in long, beside one another. Their outlines are of fresh conjoined punctures ¾ in wide and ⅛ in deep.

Along the southern edge of the rock occur (19) a large kangaroo track, and (20) a snake 3 ft 6 in long, also in a faded condition.

Ten feet east of a line of emu tracks (25) on the main rock begins a long series of figures which extend for about 180 feet to the east. The first set comprises (21) an incomplete and indeterminate figure; (22) a headless wallaby 3 ft 6 in long; and (23) a mundoe-like figure and some indeterminate lines. It is worth noting that when the tail of the wallaby, which was covered by soil and moss, was exposed its outline consisted of freshly defined conjoined punctures ¾ in wide and ¼ in deep. The other outlines are of the same type but are now smooth and indefinite due to weathering.

No. 25, the group of seven emus, and (24) their nine tracks leading westward across the rock towards the bush, constitute the finest set known of these birds among the Sydney-Hawkesbury engravings. Three of the birds are young ones from 4 to 5 ft long, the other four are adult birds 6 ft and 10 ft 6 in long, although one is much larger over-all than the others. Two of the young ones are standing erect, and the other five birds have their necks stretched out to the full as though feeding in a flock. They are all reasonably well drawn from living birds, stylized and not in motion. The three-toed foot is shown on three of them, the largest one has a band across its upper leg, and all but one have an eye. The outlines of this well preserved series are rubbed grooves from 1-1½ in wide and up to ⅛ in deep. The tracks are from 8-12 in long.

Just below the emus occur two small figures, one (26) a narrow mundoe with three toes, the other a narrow rectangular figure 15 in long.

A series of small figures extends from the emus across the lower portion of this section of the rock, comprising (27), a barred crescent, perhaps an ornament suspended on a cord; (28) a small man; (29) a leaping wallaby; (30) a barred fish of the eel-type whose tail consists of an oval weathered depression in the rock; (31) a circle with three eyes probably representing the sun or moon; (32) a boomerang of the returning type; (33) two potholes around which there are ten and seventy-one axe-grinding grooves. The outlines of five of these figures are freshly defined conjoined punctures from ¾-1 in wide and ⅛-¼ in deep, and those of the other three are also of conjoined punctures 1 in wide and ⅛ in deep, weathered to a smooth indistinct state of preservation.

Continuing southward, on another rock surface separated from the emus by a growth of grass and low bushes, are figures (34) a man in the usual upraised arms pose, (35) a bird or mammal killed with a spear, and (36) a dead scrub turkey with a broken neck, all about 3 ft long. Their outlines are of conjoined punctures 1-1¼ in wide and ¼ in deep, weathered smooth but well preserved.

Eighteen feet further east is to be seen (38) the large and imposing figure of an ancestral woman, 11 ft long and 8 feet 6 in wide from foot to foot. It has no fingers, large breasts, and a design, representing either a painted or cicatrized one, shown by parallel lines of punctures on her body, and bands across her legs. The head is the same in shape,

triangular, as that of the huge figures at the Peter Howe Trust site at Somersby (McCarthy 1947) of which there is an example in Group 10 (Series III, Fig. 6) on this ridge. It is almost identical with the large female in the North Maroota group, almost due south across the Hawkesbury River. The figure is isolated in a prominent and commanding position on the rock. Its outlines are smooth rubbed grooves 2 in wide and ½ in deep.

Fourteen feet below (38) are (37), an incomplete koala bear in profile, and (39) a small conical figure beside two short parallel lines.

Sixty-four feet across the rock, broken by a small island of grass and low bushes, is to be seen the largest number of figures in any part of the site. Nos. 40 to 59 constitute a kangaroo hunt: (40) a bulbous headed club 2 ft 6 in long; (41) a broad shield 3 ft 4 in long; (42), (43), (45) three small angled line figures; (44) a pair of kangaroo-tracks pointing south-west; (46) to (48) three baby kangaroos, 3-4 ft long, two of which are standing upright and one is on all fours. The first one has a curious mouth on its rounded head, a long barred ear, and a tasselled tail. On the other two are shown the anal chamber, a penis, and a line running from their noses to their front feet. They adjoin (49) a large buck kangaroo, 11 ft 6 in high, in a stiff upright leaping posture, with a thick humped upper body, and a V-shaped track-like figure pointing north-west within his outline; across his hind legs is (50) a broad shield, and below (51) a doe kangaroo 7 ft 6 in high, leaping along behind the buck. (51) has a band across the straight, broad tail. Also below the shield is (52) an emu's head; and (53) a returning boomerang 2 ft long.

The outlines of figures (41) to (48), (54) to (59) consist of sharply defined conjoined punctures, about 1 in wide and ⅛ in deep, but up to 1½ in wide and ½ in deep, forming a splendid example of the technique. They are little affected by weathering agencies compared with Nos. 51 to 53 whose outlines are of the same kind but now smoothed by weathering. The outlines of No. 50, the large kangaroo, are smooth rubbed grooves 1½ in wide and up to ½ in deep. All are well preserved.

A tongue of moss separates the next part of the series, which consists of: (54) and (56), two men, 5-6 ft high, each beside a broad shield (55), (57), and (58), (59) two more kangaroos, one headless, 6 ft and 7 ft 6 in high. The upper man has a broad intaglio belt across the body and large fingers on the upraised hands, the lower one has the unusual combination of eyes, nose and mouth shown on the face, and there is also a necklet and a girdle. One shield displays what are apparently four spear marks. Although the two kangaroos are depicted in a stylized pose, the straight broad tail of the upper one compared with the gracefully curved tail of the lower one is worth noting. In this hunting scene two hunters are shown, and two others are represented by their shields. The "mob" of kangaroos, with the large buck as the leader, three other adults which are probably does, and three young joeys, is the most representative, and numerically the largest, shown among the engravings of the Sydney-Hawkesbury district generally.

Another tongue of moss extending down from the top of the rock surface separates this hunting composition from two extraordinary figures. One (62) is a stingray just on 22 ft long and 10 ft wide, the outline of the body being somewhat irregular. Above it is (61) a man almost 5 ft high, and (60) a mundoe 1 ft 6 in long pointing towards the stingray. East of the stingray is (63) an unusual depiction of an ancestral being, 18 ft long. It has a seven-rayed head dress, an elongate eye, a natural depression in the rock which might indicate a mouth, two lines on the body which might indicate arms (otherwise not shown), a girdle, and one curiously shaped foot. The figure is posed in a very animated manner, and the head is turned sideways towards the stingray. Another engraving of this being is included in Group 9 (Series II, Fig. 24) on the Flat Rocks ridge and it also looks westward. The outlines of the stingray and ancestral being are rubbed smooth, the grooves being 1½ in wide and ½ in deep; that of the mundoe is of weathered conjoined punctures rather faded, and that of the man is of sharply defined conjoined punctures 1 in wide and ¼ in deep, similar to those of Nos. (41) to (48), (54) to (59).

Series IV.—A considerable area of rock on which there are no engravings extends to the east, but in the north-eastern section occur: (64) an axe-grinding groove beside a very shallow pothole which holds water only during rainy weather; (65) a wallaby 4 ft 6 in long with a tasselled tail, in an upright posture, its outline consisting of sharply defined conjoined punctures 1 in wide and 3/16 in deep where they were partly covered by soil and grass, but the exposed portion is slightly smoothed by weathering; ninety feet to the south is (68) a faded mundoe pointing eastwards, and (66), (67) four short lines, about 8 in long, engraved at one end of a weathered oval and light buff coloured depression 1 ft long in the rock, obviously to form a composite figure; one hundred and thirty feet to the east is portion of a large emu-like figure (not illustrated) now almost faded away; sixty feet further eastward near the edge of the rock surface is (69) an oval shield, just over 4 ft long. The outlines of Nos. 66 to 69 consist of conjoined punctures from ½–¾ in in diameter, and ⅛ in deep, but those of No. 69 are very narrow and are only ⅜ in in diameter.

Series V.—Across another patch of vegetation up to fifty feet wide is an undulating rock surface, tessellated on its northern side, on which there is engraved another series of scattered figures, consisting of (70) two lines of an incomplete figure; (71) a bird 3 ft long with wings closed; (72) a curious bottle-shaped indeterminate figure. Twenty-five feet to the north-east, near the lower edge of the rock, are (73), (74) two men without any unusual features, almost 4 ft long. The outlines of this series consist of conjoined punctures about 1¼ in wide and ⅛ in deep, smoothed and faded by weathering and difficult to discern.

Series VI.—Twenty feet to the east, across a narrow strip of vegetation, is another kangaroo hunting composition. (75) is a very big buck kangaroo, 14 ft long and 7 ft 6 in wide, in a leaping pose, well shaped apart from the fore-part of the body which is too thick, with bands across hind and fore limbs and on the front and hind quarters of the body. There is (76) a small man with both mouth and eyes, 4 ft high, superimposed on the kangaroo's head. The outlines are of conjoined punctures 1¼ in wide and from ¼–½ in deep, slightly smoothed by weathering but well preserved and distinct. Beside the kangaroo's foot is (77) a pothole 5 x 3 ft, with a raised boundary on one side, beside which are eleven axe-grinding grooves, and (78) two more grooves about ten feet away. The association of kangaroos with pot-holes was a practice favoured by aboriginal artists and probably indicates that these animals were commonly killed in such situations. Group 7 is another excellent example of this combination.

Thirty feet eastward, in the south-eastern corner of Flat Rocks, are (79) a goanna, and (80) a dingo, both of which are unusual and excellent figures. The goanna, 5 ft 2 in long, is a delicately portrayed example with long claws on each limb, the lines apparently indicating its pattern of body colouration. The dingo, 4 ft 7 in long, has stiff legs, upcurved tail, and angular head, with bands across its neck, forelegs, and tail. It is one of the most realistic representations of the dingo known among the engravings as a whole, and the goanna is a unique portrayal. The outlines of the goanna and dingo are rubbed grooves 1¼ in wide and ⅜ in deep, but the bands on the dingo are ½ in deep. Both figures are well preserved.

Remarks.—This is undoubtedly the principal group on Flat Rocks ridge, but Group 3, with the huge ancestral woman and other figures (Series IV, Fig. 10), Group 9, with the male and female ancestral beings (Series I, Figs. 23, 24), Group 2, the ceremonial kangaroo hunt (Series II), must also have ranked high in the ritual pattern centred on this ridge. Mundoes or human foot-tracks connect the various galleries. In Group 3 they point both towards and away from Flat Rocks, and are apparently connected with the ancestral woman. In a group one mile north of Flat Rocks, along the ridge towards Mangrove Creek, are mundoes pointing towards Flat Rocks, and on the latter site they occur at each end directed inwards towards the principal figures. Thus it is obvious that natives approached the sites from both ends of the ridge.

Features of the Flat Rocks group are (*a*) the flock of emus, (*b*) the two kangaroo hunts, (*c*) the ancestral beings and (*d*) the huge stingray. What connection existed between these four elements of the gallery is unknown. The technique makes it quite clear that the main kangaroo hunt is more recent in age than the others, but whether it constitutes a separate series is not clear. One man in this technique is placed beside the stingray, which suggests that the series might be a later addition illustrating another incident in the story.

It is obvious that there exists in this site generations of work by aboriginal artists. The faded figures present in each group are not necessarily the oldest, because it was noticeable that where portion of a figure was covered by soil or moss its outlines were sharply defined and the exposed part of the outline was considerably affected by weathering even to being difficult to discern.

Group 7.

This group is situated at the beginning of a ridge which runs along the northern side of Dinner Creek to Mangrove Creek. The military map reading is 088.727. The group is included here because it is only a few hundred yards from Flat Rocks.

Series I.—On a narrow saddle of undulating rocks are two large kangaroos, 10 ft 9in and 8 ft long. The large one is engraved on a slope of the rock, in a lifeless pose beside a large shallow depression which holds water during rainy weather; there are bands across the fore and hind parts of his body. The smaller one, thirty-seven feet to the north on a convex ridge of the rock, is stretched out flatly as though leaping at full speed, and is well proportioned. The outlines of both figures consist of conjoined punctures, now smoothed by weathering, 1 in wide and ¼ in deep. There is an extensive view from the rocks to the Sugee Bag Creek area to the north.

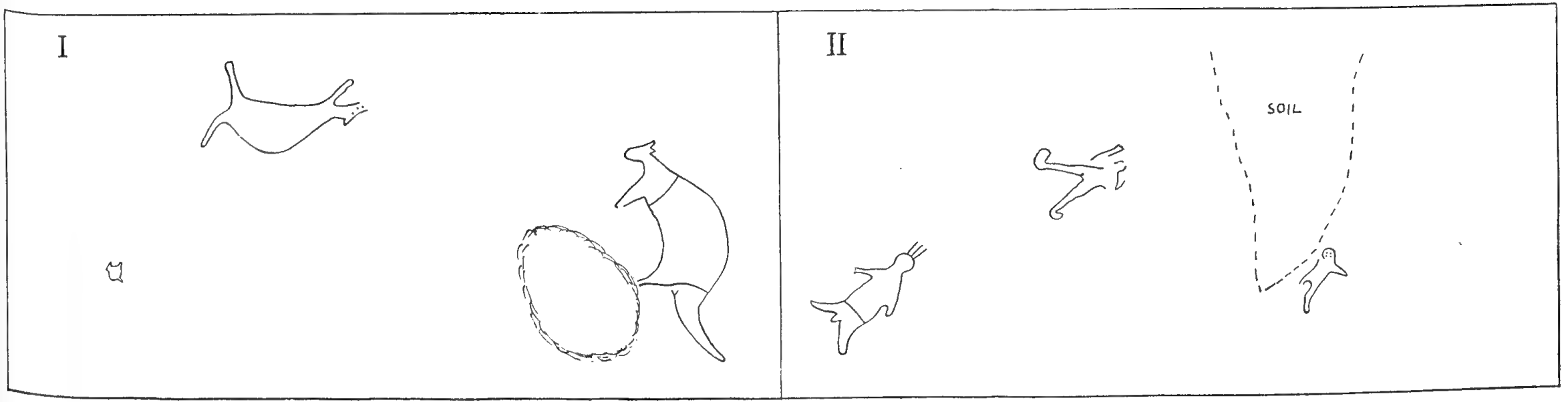


Fig. 6.—Group 7, Series I to II.

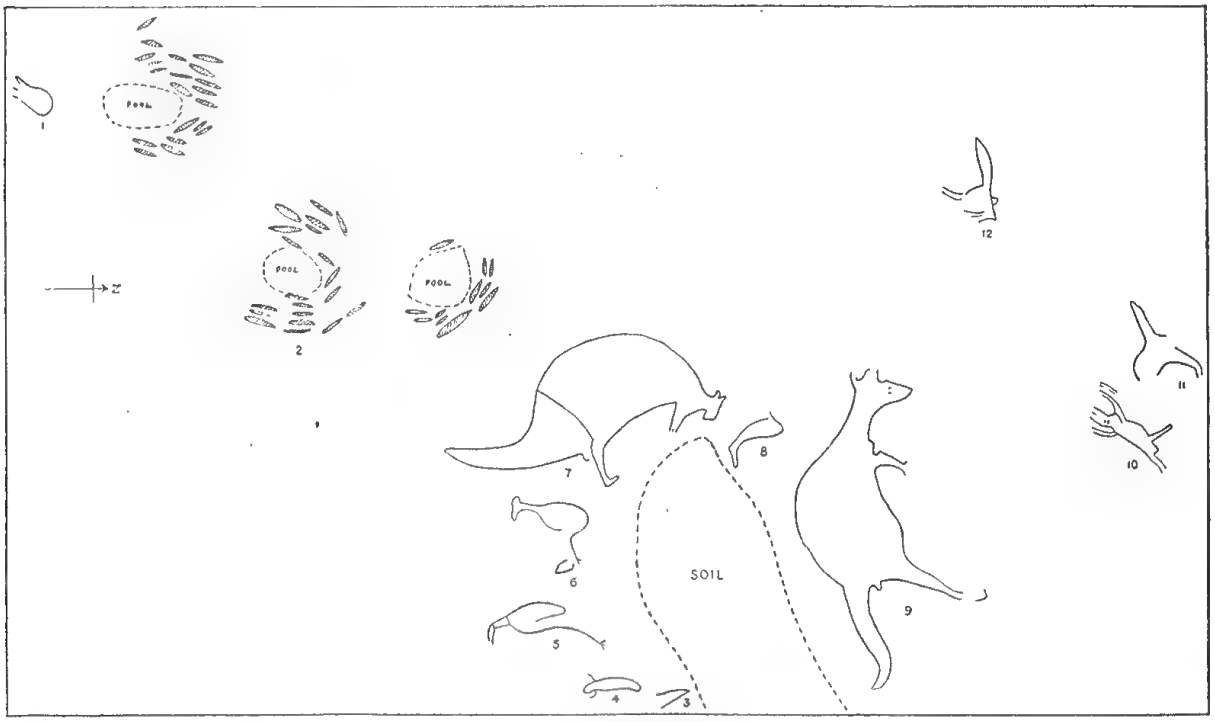


Fig. 7.—Group 8.

Series II.—On another large rock surface, flat but sloping from east to west, well down the side of the ridge about one quarter of a mile north of Series I are engraved three men of contrasting types. One has no right leg or arm but has four eyes. The middle figure, twenty-nine feet to the north, has uneven sized feet and the outlines of the arms are mixed up and indefinite. The third one, fifteen feet further north, is wearing a rayed headband and a girdle. Its rounded head is supported by a neck, and its arms point downwards, two unusual features in engravings of human figures. The outlines consist of conjoined punctures from ¾–1 in wide and 3/16 in deep, somewhat smoothed by weathering.

Remarks.—Whether the depiction of a pair of kangaroos, or other animals, as in Series I, was connected with hunting magic by the aboriginal artists is not known. Apart from a totemic significance, there are three possibilities in the interpretation of this and similar sites. One is that the animals were engraved by hunters prior to going hunting, in which case they would carry out a magical rite which might be limited to a chant to ensure the killing of big kangaroos, and the site is therefore to be regarded as one illustrating hunting magic. Another view is that the two animals were engraved as a record of a successful hunt by a party of hunters. A third interpretation is that the two kangaroos simply constitute the idle artistic expression of men camped near the site, and who knew it to be a favoured resort for these animals. It must always be borne in mind that these engravings involve a considerable amount of manual labour and time, a point which indicates perhaps a more serious interpretation than the latter one. The theme of hunting kangaroos and other animals is a recurring one among the engravings of this ridge, and it would appear to be the main inspiration for the engraving of these two animals. The three men in Series II do not appear to be connected with the kangaroos, and it is, of course, impossible to say whether they constitute a group in themselves or form part of the general pattern of engravings along the Flat Rocks ridge generally. Series of from two to five men are common among the engravings of the Sydney-Hawkesbury district, sometimes accompanied by a woman, their purpose being to illustrate or record certain social customs of which we are unaware for this area.

Group 8.

This group is situated on the main Flat Rocks ridge, about one mile east of Flat Rocks, at a military map reading of 097.724, beside the Bridle Track to Mangrove Creek. The rock surface is roughly semi-circular, about 90 feet long and wide, sloping slightly from west to east, forming the end of a rise on the ridge and at the beginning of a saddle at the other end of which is Group 9. From the site are the usual views into gorges and across the ridges. From this saddle unnamed creeks on the south side flow into Mangrove Creek, and on the north side into Sugee Bag Creek.

Figures in the main series are engraved around both sides of a shallow depression in which there is a growth of grass and low bushes in the lower middle of the rock. This depression would hold water during and after rainy weather, but it is problematic whether the Aborigines would have kept it cleaned out for this purpose unless they spent much time at the gallery.

Subjects.—At the southern end of the group is (1) a mundoe, bag-like in shape, 1 ft 6 in long, pointing south-west and 50 feet away from (2), three shallow potholes (separated from each other by a few feet), which hold water only after rain but which were filled with soil when inspected. Around them are twenty, twenty, and eleven axe-grinding grooves respectively. Thirty feet eastward are (3) a V-shaped figure, like the end of a bird's wing; (4) a lizard; (5), (6) two birds, 3 and 4 ft high, of the wading type, probably herons, at the foot of one of which is an incomplete oval figure; (7) a large and well portrayed male kangaroo 10 ft long with a very fat or broad tail, depicted in an ambling pose with its forepaws and head close to the ground; (8) a fish 2 ft long; (9) another huge kangaroo, 11 ft long, in a more upright pose than (7). Towards the northern side of the rock occur three more figures from 3 to 3 ft 6 in long, comprising (10) a man with rayed head-band; (11) a flying fox; and (12) either a bird or a second flying-fox.

Technique and Preservation.—The outlines are all of the conjoined punctured type. The punctures show clearly in some figures but are smoothed by weathering in others. They are from ¾–1 wide, and from ⅛–3/16 in deep. Several of them, particularly figures (3) and (4), (7) and (12), can only be seen in the late afternoon or early morning light but the others are well preserved.

Remarks.—This site was obviously a stopping place where hunters sharpened their stone axes and engraved a record of the game they wished to kill or had killed. It is possible that the placing of the kangaroos and birds beside the waterhole indicates that they were killed in such a situation. On the other hand, the general theme may simply be a depiction of a popular and favoured hunting place for the artists responsible for the engravings. Such a scene was commonly the inspiration for bark paintings of Arnhem Land. The fish suggests people from Mangrove Creek or Hawkesbury River. Flying-foxes are abundant in the area.

Group 9.

This group is situated on the main Flat Rocks ridge, at the eastern end of a saddle which begins at Group 8, one furlong away. The military map reading of the site is 106.725 and it is beside the bridle track to Mangrove Creek. The engravings occur on the wider end of a long rock surface which extends for some hundreds of yards as a ledge along the top of the southern side of the ridge. The ledge also extends around the end of the saddle to the northern side of the ridge, but this section and the sharply defined eastern end, bear no engravings. The rock surface is up to fifty feet wide in the area bearing the engravings, the main group of which extends for seventy feet. The two series are separated by ninety feet. Water flows across the rock in various channels during rainy weather. The view from the gallery is eastward into the headwaters of Screech Owl Creek.

Series I.—At the western end is (1) a curious but indeterminate series of large rounded punctures 1-1½ in in diameter engraved in a hook design 3 ft 3 in long; (2) a young striped emu 4 ft 4 in high, with what appears to be a spear in its lower breast; (3) a wallaby; (4) another young emu; (5) a bird track, apparently of an emu, pointing to the south-east; (6) a boomerang; (7) an unusual figure which is probably a flying-fox; (8) a wallaby; (9) a tailless kangaroo 5 ft high, with three eyes; (10) a bird; (11) a well posed kangaroo 5 ft 9 in long; (12) an oval; (13), (14) two incomplete and indeterminate figures. In a separate set near the lower edge of the rock are (15) a bird; (16) an eel; (17), (18) two men, smaller than natural size; (19), (20) two boomerangs. The central series of figures comprises (21), (22) incomplete animals; (23), (24) a culture hero 12 ft high, and his wife 9 ft high; (25) an indeterminate but interesting mammal, probably a native tiger-cat; (26) three boomerangs, one of which is a right-angled returning type; (27) portion of a man.

Series II.—The scattered figures at the eastern end of the outcrop comprise (28) a wallaby 4 ft 6 in long; (29) flying-fox; (30) goanna; (31) six axe-grinding grooves.

Technique and Preservation.—The outlines of practically all these figures are from ¾-1 in wide, and ⅛-3/16 in deep. They all consist of overlapping or conjoined punctures, showing out conspicuously in the young emu, and in the wallaby and flying-fox at the eastern end. The outlines of many of the figures have been smoothed by weathering and flowing water but none of them is rubbed. It was only after several examinations that the full series was discerned.

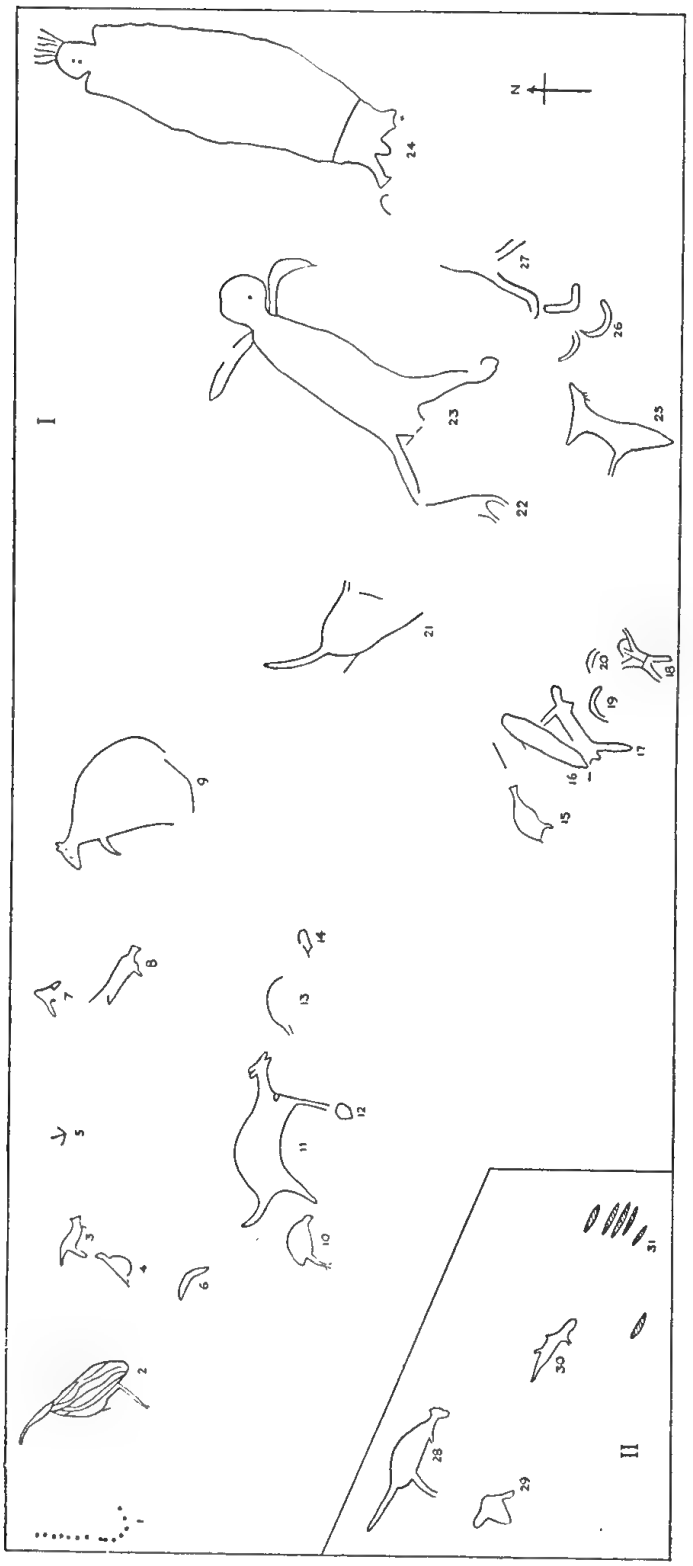


Fig. 8.—Group 9, Series I to II.

Remarks.—The most notable feature of the group is that the culture-hero, armless and wearing a rayed head-band and apparently portrayed from the side, is exactly the same in style as the one on Flat Rocks, though it is not as large. The wife, however, is shown in a different posture. They are also associated in both groups with kangaroos and emus as the principal animals, although birds, wallabies, a native cat, and a flying-fox also occur in this series. The weapon featured is the boomerang which apparently was in common use in this area. The site is probably a spirit-centre, totem-centre, and initiation ground, illustrating an incident in a legend.

Group 10.

This group is situated on the main Flat Rocks ridge, forming a complete saddle about one mile east of Group 9 at a military map reading of 105.732. The saddle is one rock surface divided into five separate areas by islands and strips of grass and low vegetation with one or two trees on the southern side. The whole of the rock surface bears a series of parallel cracks bisected in places by others at right angles, to form tessellations. The northern side of the saddle is a high, steeply sloping rock face. The view is into the headwaters of Screech Owl and Sugee Bag Creeks. The site includes 145 figures, and numerically is the most extensive recorded in the Sydney-Hawkesbury district. It will be described in six separate series, from east to west across the saddle.

Series I.—From south to north are the following figures: (1) two small ovals; (2) a large oval; (3) young wallaby; (4) bird; (5) four tiny figures of an oval, bird's head, and two incomplete figures; (6) incomplete boomerang; (7) portion of a bird; (8) incomplete figure; (9) goanna; (10) oval; (11) wombat; (12) man; (13) goanna; (14) indeterminate; (15) flying-fox; (16) shield; (17) oval.

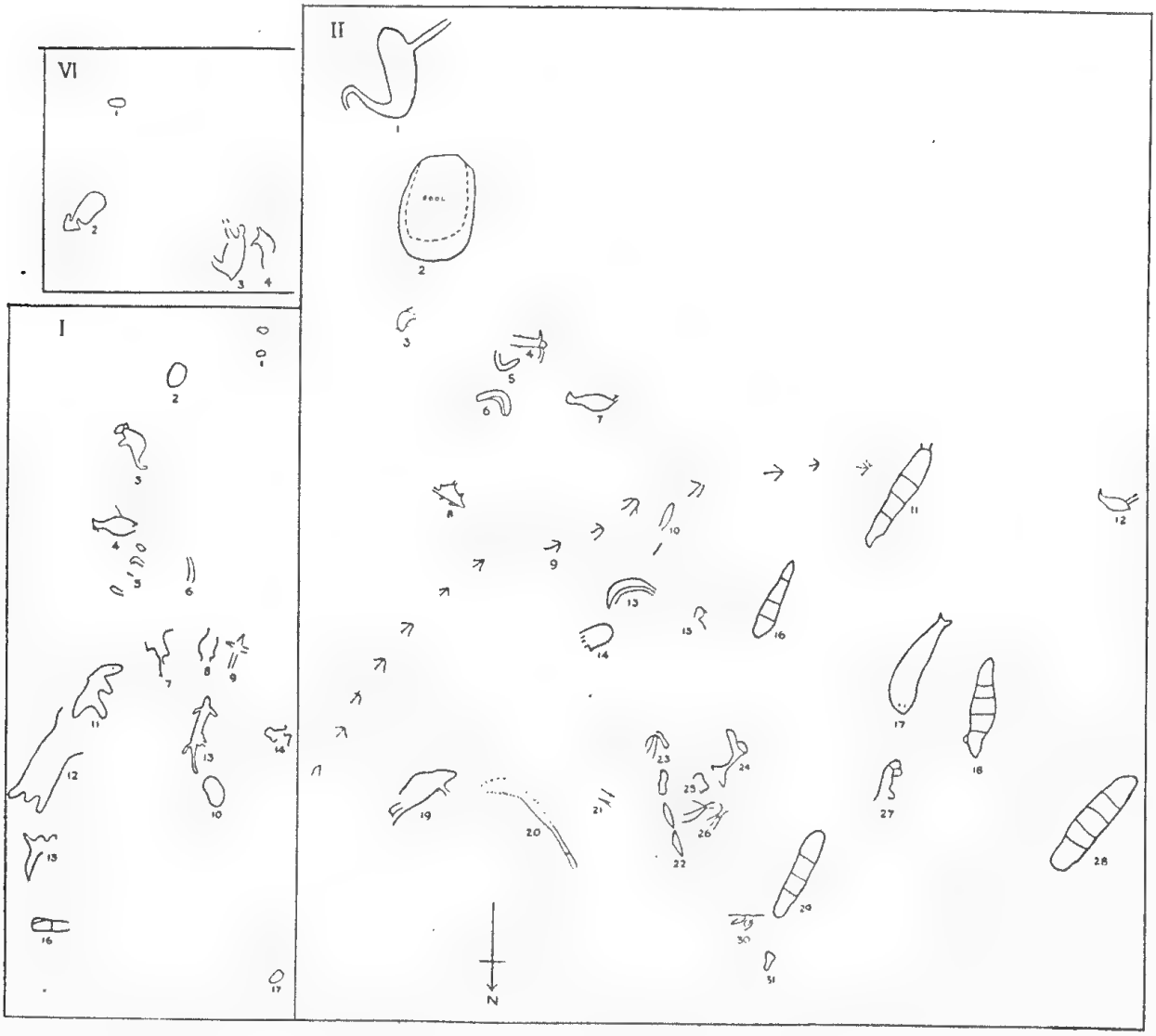


Fig. 9.—Group 10, Series I to II, VI.

The outlines are all about ½ in wide and from ⅛-3/16 in deep and suggest work done by one generation and school of artists. They form a heterogeneous series of small figures, engraved without any apparent pattern or connection.

Series II.—From south to north are the following figures, engraved on an oval area of rock with a convex surface: (1) emu, gracefully posed, with head and neck withdrawn in a characteristic posture; (2) oval pool, only 1 in deep, encircled by a punctured line; (3) small mammal; (4) upper part of a man; (5)-(6) boomerangs of returning type; (7) bird; (8) small mammal; (9) crescentic line of fourteen bird tracks; (10) elongate oval figure; (11) barred fish; (12) bird; (13) broad boomerang; (14) large human foot-track; (15) incomplete figure; (16) barred fish?; (17) fish of flathead type; (18) barred fish; (19) mammal; (20) indeterminate figure merging into natural cracks to form what appears to be a club; (21) pair of kangaroo or wallaby tracks; (22) three oval figures, the top one probably a mundoe; (23 to 27) indeterminate figures; (28), (29) barred fish or bark canoes; (30) indeterminate; (31) hourglass-shaped figure.

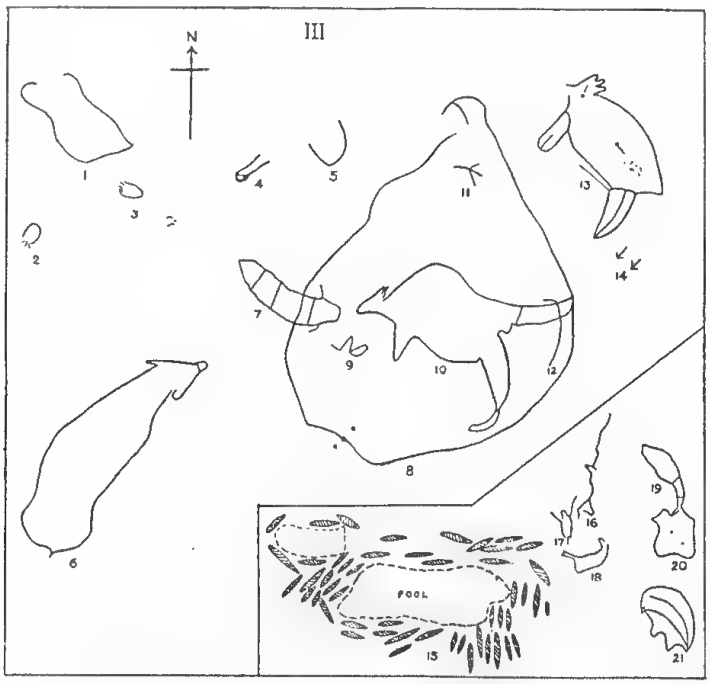


Fig. 10.—Group 10, Series III.

In various sections of this series there is some connection between figures. Thus the emu (1) is obviously standing beside a pool of water, and is apparently recorded as an observation by the artist. The barred figures (11, 16, 18, 28, 29) possess in Nos. 11 and 18 the characteristics of a fish, but the others are suggestive of bark canoes. Perhaps they represent both fish and bark canoes according to whether the anterior fins are indicated or not. Nos. 4 to 7 suggest a composition of a man throwing boomerangs at a bird. The line of bird tracks runs across the rock from Series I towards Series III, but its significance is not known. In Series II, (26) is unusual in type. Nos. 7 and 12 are obviously illustrations of the same bird but the species is indeterminate.

Technique and Preservation.—Most of the figures in this series have outlines about ½ in wide and ⅛ in deep, but in (22) oval, (9), line of bird tracks, and (28) barred figure, they are 1 in wide and 3/16 in deep. Most of these figures are well preserved and were apparently never any deeper, but they are difficult to discern because lichen in the grooves has given them the same weathered colour as the rock surface, and it is necessary to search for some of them in the early morning or late afternoon light.

Series III.—Situated on a sloping area of rock at the western end of the group. From north to south are the following figures: (1) Mammal?; (2), (3) two human foot tracks leading off the rock to the west; (4) (5) two incomplete and indeterminate figures; (6) a large elongate flat-nosed figure, possibly an ancestral platypus, 8 ft long; (7) barred fish; (8) large bird, 12 ft high and 9 ft 6 in wide, with an unusually fat body. The beak suggests an eagle, but the body is that of a ground bird; (9) indeterminate, possibly a bullroarer on a string; (10) leaping kangaroo struck on the leg by a boomerang; (11) bird track pointing southwards; (12) curved line; (13) large mammal of indeterminate species; (14) pair of bird tracks; (15) shallow pools surrounded by forty-nine axe-grinding grooves; (16) line figure; (17) flying bird or flying-fox; (18) dead bird; (19) fish; (20) flying-fox; (21) echidna, particularly well posed.

Technique and Preservation.—The outlines of most of these figures are about ½ in wide and from ⅛-3/16 in deep, but those of Nos. 6, 8, 10, 13 and 21 are 1 in wide and from 3/16-¼ in deep. In the main they are not easy to discern, in fact Nos. 2, 3, 6, 8 were not found until a third search of the rock had been made in the best possible light. The outlines have all assumed the same patina and colouration as the rock surface.

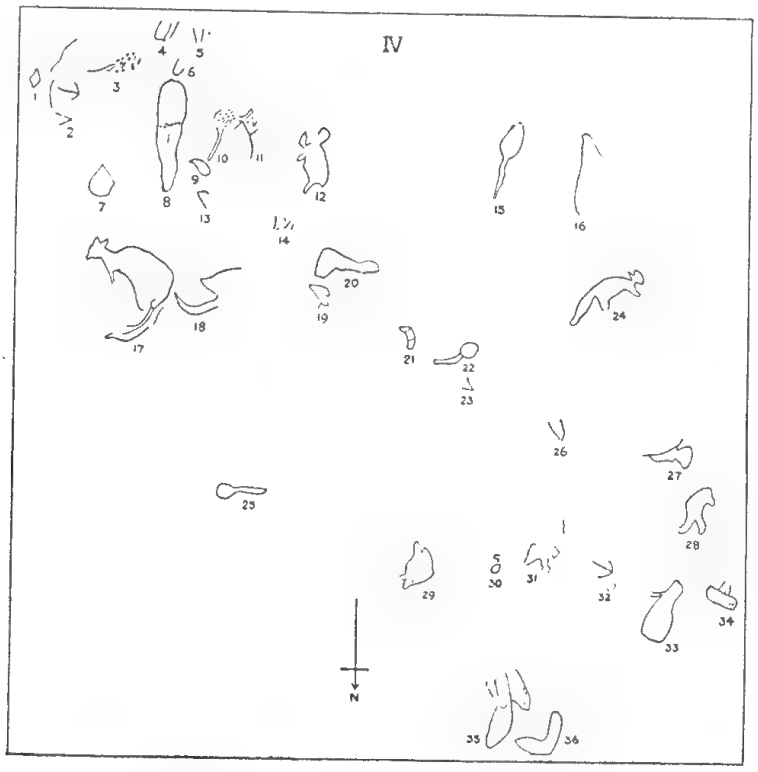


Fig. 11.—Group 10, Series IV.

Remarks.—This is undoubtedly the most important series of the six in this gallery as indicated by the large figures (Nos. 6 and 8 particularly; also Nos. 10 and 13) and by the presence of both human and bird tracks. No. 13 is a unique figure. The huge size of Nos. 6 and 8 indicates mythological associations, but both are indeterminate apart from No. 8 being the figure of a bird. Its great body raises the question again of the function and significance of such figures. Are they in themselves spirit-centres for totemic clans, the place in the rock where the ancestral beings desposited or embedded their supplies of eternal spirits to be reincarnated generation after generation? Or are they simply gigantic creatures typical of the dream-time world of the Aborigines, contesting with one another various rights, preying upon one another, and in other ways carrying out activities which form so important a part in the mythologies of Australian tribes as a whole? The line of bird tracks in Series II leads to Series III, and the bird and human tracks in the latter could form one track, as in other groups, although here they lead away off the rock to the north-east. Nos. 6, 8, and 13 are all unusual figures, but No. 6 is represented at the Peter Howe Trust, Somersby (McCarthy: 1947: 322-29 pl. A.D.) by three similar monsters from 22 to 32 ft 6 in long which I described as Rainbow-serpents. Smaller figures of this kind, commonly regarded as eels, occur throughout the engravings of the Sydney-Hawkesbury district. The flat beak of No. 6 suggests a platypus but on the other hand, the thin, short tail suggests a wombat, although it probably represents neither of these mammals. It is drawn from above and thus represents an animal commonly seen from that angle. Mammals are always shown in profile because they are viewed most commonly from the side.

Series IV, situated to the south of Series III on an oval and flat section of tessellated rock: Most of the figures are small enough to fit into one tessellation. They comprise from east to west: (1) lozenge-shaped figure; (2) pair of bird tracks pointing northward; (3) stem of a plant bearing edible rhizomes or bulbs; (4) portion of a bird; (5), (6) indeterminate and incomplete; (7) pointed oval; (8) indeterminate figure with line of large punctures 1 in in diameter across the middle; (9) bird; (10), (11) club, or root food similar to No. 3; (12) mammal; (13), (14) incomplete; (15) tadpole; (16) incomplete; (17) kangaroo lying down; (18) posterior portion of an emu; (19), (20) indeterminate; (21) boomerang; (22), (25) spherical-headed clubs; (24) a wallaby; (23), (26), (27) incomplete

and indeterminate (28) possum; (29) echidna; (30) oval and line, probably a bullroarer; (31) indeterminate; (32) bird track and small circle, probably representing a bird beside a waterhole; (33), (34) indeterminate mammals or insects; (35) indeterminate, with spotted figure adjoining; (36) boomerang, probably thrown at the rodent.

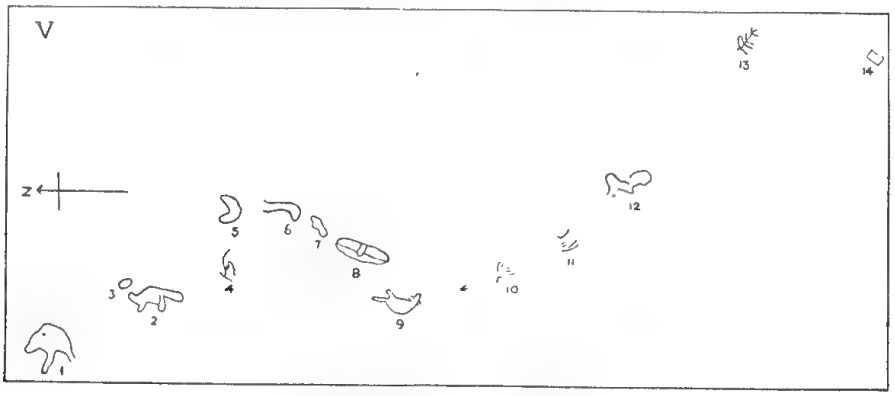


Fig. 12.—Group 10, Series V.

Technique and Preservation.—The outlines are all about ½ in wide and from ⅛–3/16 in deep. All appear to have been done by the one generation of artists. Many are difficult to discern because the patination of their outlines is the same as that of the rock.

Remarks.—The range of subjects is highly varied in this series. It includes clubs and boomerangs which were evidently thrown commonly at birds and mammals, as illustrated in other groups along this ridge, and in Nos. 25 and 36 in this series. Unusual and unique figures here include Nos. 3, 10, 11, which appear to depict edible roots on a stalk, possibly of a sedge, and No. 15, the tadpole. The pair of bird-tracks (2) point towards Series II in which there is a line of them. A number of indeterminate and incomplete figures are represented. Apart from the hunting motive, there is no apparent pattern in this series.

Series V.—Situated on a long sloping but flat rock surface across the southern end of the group and of the saddle. From north to south are the following figures: (1) indeterminate animal; (2), (3) possum and circle; (4) indeterminate; (5) boomerang; (6) bird's (emu) head; (7) human foot-track; (8) shield; (9) wallaby; (10) to (12) indeterminate; (13) backbone motive, or leaf-frond; (14) rectangle.

Technique and Preservation.—The outlines are all about ½ in wide and from ⅛–3/16 in deep. The figures are engraved mostly along the northern edge of this rock surface where it joins a strip of vegetation.

Remarks.—This is a series of odd figures, unrelated to any of the other series. Nos. 5 to 8 appear to represent the hunting of a bird whose head is shown, as is the boomerang thrown at it, the hunter's foot track and his shield.

Series VI, situated on a small flat but sloping area of rock at the western end of the group, above series III. The bridle track passes across this rock. They comprise: (1) oval, possibly a human foot-track; (2) indeterminate; (3), (4) two mammals, probably wallabies. Their outlines are ½ in wide and from ⅛–3/16 in deep. They are well preserved and distinct.

General Remarks.—This gallery, comprising 145 figures, contains more engravings than any other site on Flat Rocks ridge. In most of the outlines overlapping or conjoined punctures are distinct, and none of the outlines has been rubbed. Most of the outlines, also, are about ½ in wide and from ⅛–3/16 in deep, and suggest the work of one generation and school of artists. It is interesting to note that the outlines of most of these figures have assumed the same colouration, with lichen, as the rock surface itself, but this process can take place in less than one hundred years, as shown by the initials of white men engraved on sandstone rocks in some localities. It is not, therefore, a reliable indication of age.

A ritual motive is suggested in Series III, and the various series are linked here and there by either bird or human foot tracks. Otherwise, apart from hunting compositions, there appears to be no apparent pattern throughout the gallery as a whole. An impressionistic portrayal of action is recorded in the hunting composition, shown in Series V, Nos. 5 to 8, consisting of a boomerang, bird's head, hunter's track and shield.

The occurrence of so large a number of axe-grinding grooves at this site strengthens the theory that the carvings were done by people of the Eloueran culture, as suggested previously (McCarthy: 1948, 30).

FOODY-SCOTCHMAN'S CREEK RIDGE

This ridge runs from Flat Rocks *via* Foody Trig. Station to Mangrove Creek, and forms at its eastern end the southern side of Scotchman's Creek valley.

Group 11.

This small but interesting group is situated on the second saddle along the ridge between Flat Rocks and Foody Trig. Station, at a military map reading of 087.714. The figures are engraved on a series of small and separate blocks of rock beside the track in the middle of the saddle. These soft white sandstone rocks are in an unusual position for a group of engravings. The view is restricted by forest and scrub. The little creeks beginning at this saddle form part of the headwaters of Gunderman and Dinner Creeks.

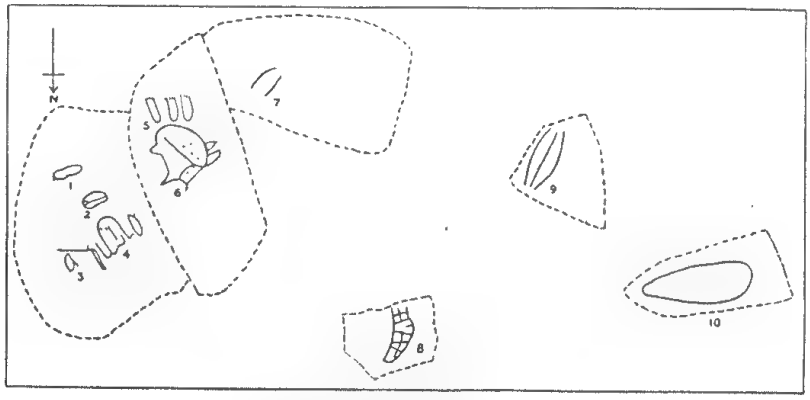


Fig. 13.—Group 11.

From east to west are the following figures: (1) human foot track; (2) barred oval; (3), (4) indeterminate; (5) three mundoes beside one another in a parallel set; (6) a beautifully portrayed echidna, bearing a few dots and two projections on the back which might be intended to indicate the spines; (7) incomplete; (8) barred, crescentic figure (like a snake's head); (9) shield; (10) oval, probably another shield.

Technique and Preservation.—The echidna and human foot-tracks have smooth rubbed outlines from 1–1½ in wide and ⅜ in deep. The outlines of the other figures are from ¾–1 in wide and from ⅛–3/16 in deep. They are all clear and well preserved. Overlapping punctures show out clearly in several of the figures.

Remarks.—The principal motive in this group is that of hunting echidna and flying-fox. There is obviously a connection between the echidna and the hunter's feet, and similarly between the flying-fox and the other figures on the same rock. No. 1, however, is a human foot-track pointing towards Flat Rocks, and it is worth noting that another one occurs on the first saddle halfway between this site and Flat Rocks, carved on a large rock surface on the eastern side of the saddle. These tracks thus indicate a sacred pathway to the major Flat Rocks group.

Group 12.

Situated about halfway along the ridge between Foody Trig. Station and Mangrove Creek, at a military map reading of 115.683. The figures are engraved on two of a number of rock surfaces on the side of the ridge, at the beginning of a saddle. There is a view into the Breakfast Creek gorge.

On a flat rock sloping slightly to the south and east are engraved a (1) koala bear in profile, and (2), (3) two fish, one of the flathead type. About 60 ft to the east, on a higher ledge of rock, a set of three boomerangs (4) is engraved one above the other; one of them is notable for the concave shape of one arm. They are all about natural size. The fish indicate that river people were the artists responsible for this group.

Technique and Preservation.—The figures are clear and well preserved, and the outlines are only slightly smoothed by weathering. Portion of the koala was covered with soil and moss and when this was cleared away a sharp outline of conjoined punctures was exposed which contrasted noticeably with the slightly weathered remainder of the outline of this figure. All of the outlines consist of conjoined punctures from ½–¾ in wide and 3/16 in deep.

Group 13.

This group is situated a mile east of Group 12, at a military map reading of 121.686. The site is a prominent and extensive sloping rock surface (corrugated in many places by running water, after rains), which extends along the northern and eastern sides of a high rocky knob on the ridge. The area of rock surface bearing the engravings is about 500 ft long and up to 100 ft wide. From it is seen a magnificent view into the gorge of a tributary of Dinner Creek and across the ridges behind it. The figures are scattered and difficult to find. They comprise, from east to west; (1) profile view of man with rayed headband; (2) human foot-track; (3) bust of a man; (4) circle; (5) elongate fish, barred, like a flathead; (6), (7) axe-grinding grooves; (8) mammal like a possum; (9) anterior portion of a kangaroo; (10) indeterminate; (11) man, with axe-groove beside his hand.

Technique and Preservation.—The outlines of all the figures are about ½ in wide, and from ⅛–3/16 in deep, and consist of conjoined punctures. Nos. 1 and 5 are distinct and well preserved but the remainder are faint and may only be seen in the best light of late afternoon and early morning.

Remarks.—In reference to No. 4, a circle, it is worth noting that on this rock a number of natural ovals occurs, slightly irregular in shape in some instances; in one place at the eastern end there are three of them in a north-south line, which may have represented human tracks to the Aborigines. No particular interpretation can be placed upon such a group of old and scattered figures, but the small and well portrayed No. 1 is an unusual and important figure.

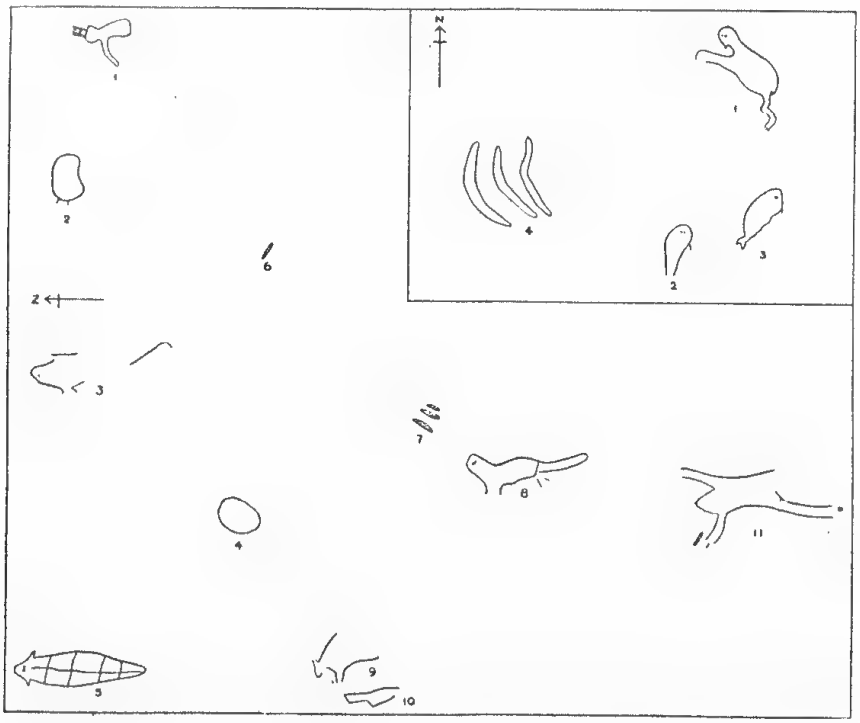


Fig. 14.—Left and bottom: Group 13. Top right: Group 12.

DISCUSSION

The many unusual features of, and unique figures in, the Flat Rocks ridge galleries are mentioned in the remarks about each site and need not be repeated.

The initiated men appear to have made periodical visits for hunting and ceremonial purposes to Flat Rocks ridge, and probably to the surrounding country generally. In the summer months these ridges are hot and inhospitable, rough underfoot, and water has to be sought in the creeks at the bottoms of the gorges. The same difficulty exists in regard to water during dry and drought periods. While the native men may not have minded visits under these conditions for ritual purposes, I believe that they would have preferred to remain near their river camps until rains created favourable conditions for these excursions during many of which, apparently, it was essential to have water in the pot-holes on the rocks as an aid in the grinding of axe-blades. Furthermore, it was probably necessary for the men to get the permission of their ceremonial leader, the one responsible for the sacred sites on Flat Rocks ridge, before they could visit any of the galleries.

Family groups of Aborigines lived along the Hawkesbury River, Mangrove Creek, and other main streams, where numerous kitchen-middens testify to long occupation. The rock-shelters that I have examined on the sides of the ridges in the vicinity of the engravings bear no trace of occupation. The general hunting of game by the men, and the collecting of plant foods by the women, was no doubt done on the ridges and in the valleys nearer the river and away from this sacred ridge.

A point of some importance is that Group 6, the Flat Rocks gallery, contains figures of a female ancestral being, emus, and a kangaroo hunt very similar to those of these subjects in the extensive gallery at North Maroota, on the opposite side of the Hawkesbury River, and about three or four miles from its southern bank. At the latter site, also, a kangaroo is shown struck by a large number of boomerangs, as in Group 2 (Series II), on Flat Rocks ridge. It is obvious that the local groups of natives on both sides of the river shared the same mythology but portrayed the characters in a slightly different manner. Mutual visits were probably made to each other's ceremonial grounds during the performance of the totemic and historical ceremonies.

This ridge is one of the few places in the Sydney-Hawkesbury district where a complete, or almost complete, series of petroglyphs of one local group or tribe exists for study as an entity. Here are assembled the body of artistic symbols of tribal religion which, since petroglyphs were first made in the area, was guarded by generations of aboriginal men from the uninitiated and the womenfolk.

The thirteen galleries herein described contain the imposing number of 279 engravings, in addition to which there are approximately 290 axe-grinding grooves around 16 potholes. As many of the petroglyphs are large ones, and some of the punctured outlines have been rubbed smooth, it is obvious that Flat Rocks ridge was a resort of the local and other natives for a long period of time. Some of the carvings are now so faint that they can be discerned only in the morning or late afternoon light, and then only by those with some experience of petroglyphs, but how long such a weathering process has taken in this area is still unknown. Attention has been drawn to the fact that the outlines of some figures, where exposed, show considerable deterioration caused by weathering influences, whereas other portions of these outlines covered by moss or soil are sharply defined and perfectly preserved. The axe-grinding grooves were probably produced intermittently during and after rainy weather, and their large number supports the idea of a considerable relative local antiquity for these galleries.

Table 1.—Subjects: Distribution.

The subjects and their distribution among the various galleries are as follows:—

	1	2	3	4	5	6	7	8	9	10	11	12	13		
Kangaroos or wallabies	5	4	3	3	...	12	2	2	5	6	...	...	1	43	
„ „ tracks ...	...	...	...	...	...	2	...	...	...	2	...	...	...	4	
Koala bear	...	1	...	...	...	...	...	...	...	...	...	1	...	2	
Dingo	...	2	...	...	...	1	...	...	...	...	...	...	...	3	
Possum	...	...	1	...	...	...	...	...	...	2	...	...	1	4	
Wombat	...	...	...	...	...	...	...	...	1	...	...	...	...	1	
Tiger cat	...	...	...	...	...	...	...	...	1	...	...	...	...	1	
Echidna	...	...	...	...	...	...	...	...	...	2	1	...	...	3	
Flying fox	...	...	...	...	...	1	...	2	2	3	1	...	...	9	
Indeterminate mammals	1	...	1	...	...	2	...	...	...	10	...	...	...	14	
															84
Emu	1	...	4	...	...	9	...	...	2	3	...	...	...	19	
Pelican	1	...	...	...	...	...	...	...	...	...	...	...	...	1	
Scrub turkey	...	1	...	...	...	1	...	...	...	...	...	...	...	2	
Goose	...	...	1	...	...	...	...	...	...	...	...	...	...	1	
Heron	...	...	...	...	...	...	...	2	...	...	...	...	...	2	
Clutch of eggs	...	...	1	...	...	...	...	...	...	...	...	...	...	1	
Bird tracks	...	...	...	...	...	9	...	...	1	20	...	...	...	30	
Indeterminate birds	...	...	...	...	...	1	...	...	2	8	...	...	...	11	
															67
Snakes	...	...	2	...	...	...	...	...	...	...	...	...	...	2	
Goanna	...	...	...	...	...	1	...	...	1	2	...	...	...	4	
Tadpole	...	...	...	...	...	...	...	...	...	1	...	...	...	1	
															7

	1	2	3	4	5	6	7	8	9	10	11	12	13		
Swordfish	...	...	1	...	...	...	...	...	...	...	...	...	...	1	
Eel	...	...	3	...	...	1	...	...	1	5	...	...	...	10	
Flathead	...	...	...	...	...	...	...	...	...	1	...	...	1	2	
Stingray	...	...	...	...	...	1	...	...	...	...	...	...	...	1	
Indeterminate fish	...	...	...	...	...	...	...	1	...	1	...	2	...	4	
															18
Culture-hero—															
Male	...	...	...	...	...	1	...	...	1	...	...	...	...	2	
Female	...	...	1	...	...	1	...	...	1	...	...	...	...	3	
															5
Men	...	...	2	1	...	11	3	1	2	2	...	...	3	25	
Women	...	1	...	...	...	...	...	...	...	...	...	...	...	1	
Human leg	...	...	1	...	...	...	...	...	...	...	...	...	...	1	
Human hand	...	...	1	...	...	...	...	...	...	...	...	...	...	1	
Human tracks	4	...	4	3	2	10	...	...	...	7	4	...	1	35	
															63
Plants	...	...	...	...	...	...	...	...	...	2	...	...	...	2	2
Boomerang	4	12	4	...	...	2	...	...	6	8	...	3	...	39	
Club	...	...	1	...	...	1	...	...	...	2	...	...	...	4	
Spear	...	...	...	...	...	...	...	...	1	...	...	...	...	1	
Spear-thrower	...	...	1	...	...	...	...	...	...	...	...	...	...	1	
Shield	...	...	1	...	...	3	...	...	...	2	2	...	...	8	
															53
Ornament	...	...	...	...	...	1	...	...	...	...	...	...	...	1	1
Oval-circular	2	...	...	1	...	5	...	...	1	11	...	...	1	21	
Linear	2	...	4	...	...	4	...	...	1	6	1	...	...	18	
Barred oval	...	...	...	...	...	...	...	...	...	...	1	...	...	1	
Parallel lines	...	...	...	...	...	1	...	...	...	...	...	...	...	1	
Backbone design	...	...	...	...	...	...	...	...	...	1	...	...	...	1	
															42
Indeterminate	...	...	2	2	...	2	...	...	3	25	...	...	1	35	35

The table reveals that kangaroos, emus, boomerangs and men are the outstanding single motifs in the sites as a whole. The mammals and birds are numerically stronger than the fish, but nearer the coast the fish outnumber these subjects. There are forty-four identifiable subjects, but many of the figures in the indeterminate series were no doubt separate subjects to the Aborigines.

It is most probable that the ten galleries on Flat Rocks ridge belonged to a mythological saga which embodied beliefs about totems and spirits, and about the lives of the ancestral beings who are portrayed. Two sets of male and female heroes, probably husband and wife in each case, engraved in the one group occur in Groups 6 (Series III, Figs. 38, 63) and 9 (Series 1, Figs. 23, 24) and there is in addition the remarkably large figure of a female ancestral being in Group 3 (Series IV, Fig. 10). Their names are unknown, but they are representative in this area of the All-Father (Baiami-Daramulan complex) beliefs and rites connected with the Bora type of initiation ceremonies widespread in south-eastern Australia. The human foot tracks, or mundoes, engraved on the rocks, and probably others made in the soil during ceremonies, linked together some of the groups associated with the ritual path along the ridge. The recurrent motif of hunting with the boomerang, particularly of kangaroos but also of echidna, emus and geese, illustrates an important theme in the daily life of these natives. It may have been inspired by hunting magic or by the desire to record success, but the kangaroo hunting episodes shown in Groups 2 (Series II, Figs. 8 to 10) and 6 (Series III, Figs. 40 to 59; Series VI, Figs. 75, 76) are obviously of mythological significance. Although there were many other totems besides the kangaroo and emu, these two overshadow all others because of their economic and mythological importance.

References.

Berndt, R. M. 1947. Wuradjuri magic and "clever men". *Oceania*, 18. 60-86.

McCarthy, F. D. 1941. Records of the rock engravings of the Sydney district. Nos. 1-7. *Mankind* 3: 42-56, pls. I-M.

————————, 1944. Nos. 8-20. *op. cit.* 3: 161-71, Figs. I-XI.

————————, 1945. Nos. 21-32. *op. cit.* 3: 266-74, pls. T-U.

————————, 1946. Nos. 33-37. *op. cit.* 3: 266-72, pls. Z-ZZ.

————————, 1947. No. 38. *op. cit.* 3: 322-29, pl. AD.

————————, 1949A. Nos. 39-40, *op. cit.* 4: 61-67, pls. C-E.

————————, 1949B. Nos. 41-55. *op. cit.* 5: 5-32, Figs. I-XI, pls. A-C.

————————, 1948. The Lapstone Creek excavation; two culture periods revealed in eastern New South Wales. *Rec. Aust. Mus.* 22: 1-34, pls. 1-4.

Mathews, R. H. 1895. Rock carvings and paintings of the Australian aborigines. *J.Anthr.Inst.Gt.Brit.Irel.* 26: 145-63, pls. 14-16.

————————, 1898. *op. cit.* 27: 532-41, pls. 29-30.

————————, 1895. Rock paintings and Carvings of the Aborigines of New South Wales. *Rept. A.A.A.Sc.* 6; 624-37, pl. 99.

————————. 1899. Rock carvings of the Australian Aborigines. *Tr.Pr.Roy.Geogr.Soc.Austr.,Q'Ind.Br.*, 14: 9-11, pl.

Explanations of Plates.

Plate 3.

1. Site of Group 3, looking east.
2. Site of Group 6, Flat Rocks, looking east.
3. Site of Group 8, looking north into the headwaters of Sugee Bag Creek.
4. Site of Group 9, looking east, with N. Camps on left. The rock is soft, much of it pale brown in colour, lacking a lichen-covered and weathered surface.
5. Portion of Group 10, showing the cracked nature of the rock surface and the disposition of the carvings.
6. Recording grid, with compass, on human figure (Group 4, Series I, Fig. 16).

Plate 4.

1. Upper portion of an ancestral being, 18 ft high, in Group 6 (Series III, Fig. 63), showing smoothed outline.
2. Ancestral being, 12 ft high, wearing a girdle (Group 9, Series I, Fig. 24).
3. Female ancestral being with smoothed outline, 11 ft high (Group 6, Series III, Fig. 38).
4. Head of female ancestral being with smoothed outline, 18 ft high (Group 3, Series IV, Fig. 10).
5. Profile view of a small human figure wearing a rayed headband (Group 13, Fig. 1).
6. Indeterminate mammal, and head of large bird, 12 ft high, with tracks (Group 10, Section III, Figs. 8, 11, 13, 14).

Plate 5.

1. Portion of a kangaroo hunt (Group 6, Series VI, Figs. 75, 76).
2. Two baby kangaroos (Group 6, Series III, Figs. 47, 48), showing conjoined punctures in outlines.
3. Portion of Group 8, showing birds and kangaroo engraved around a depression in the rock.
4. Wallaby struck by a boomerang (Group 3, Series I, Fig. 1).
5. Goanna and dingo. (Group 6, Series VI, Figs. 79, 80) with smoothed outlines.
6. Human tracks (mundoes) and echidna (Group II, Figs. 5 and 6).

Plate 6.

1. Emu, 9 ft high (Group 3, Series V, Fig. 19).
2. Portion of a line of fourteen bird tracks (Group 10, Series II, Fig. 9).
3. Goose struck by boomerang, beside circle (Group 3, Series V, Fig. 16).
4. Tadpole (Group 10, Series IV, Fig. 15).
5. Hooked line of large punctures 1 to 1½ in diameter (Group 9, Series I, Fig. 1).
6. Axe-grinding grooves around pothole (Group 8, Fig. 2).

Sydney: A. H. Pettifer, Government Printer—1956.

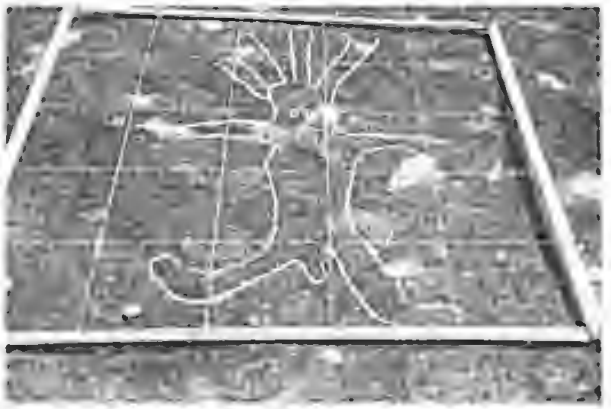
1

2

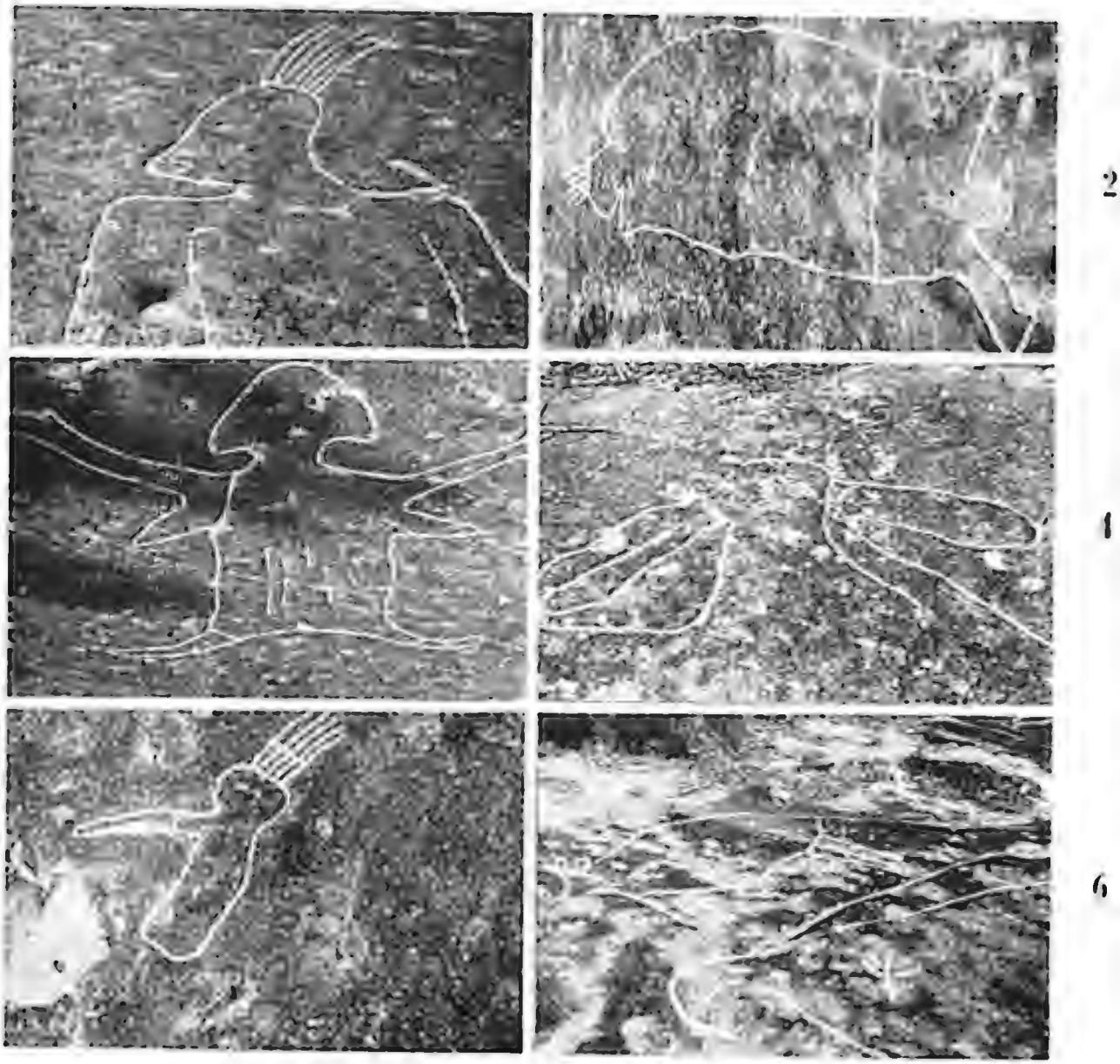
3

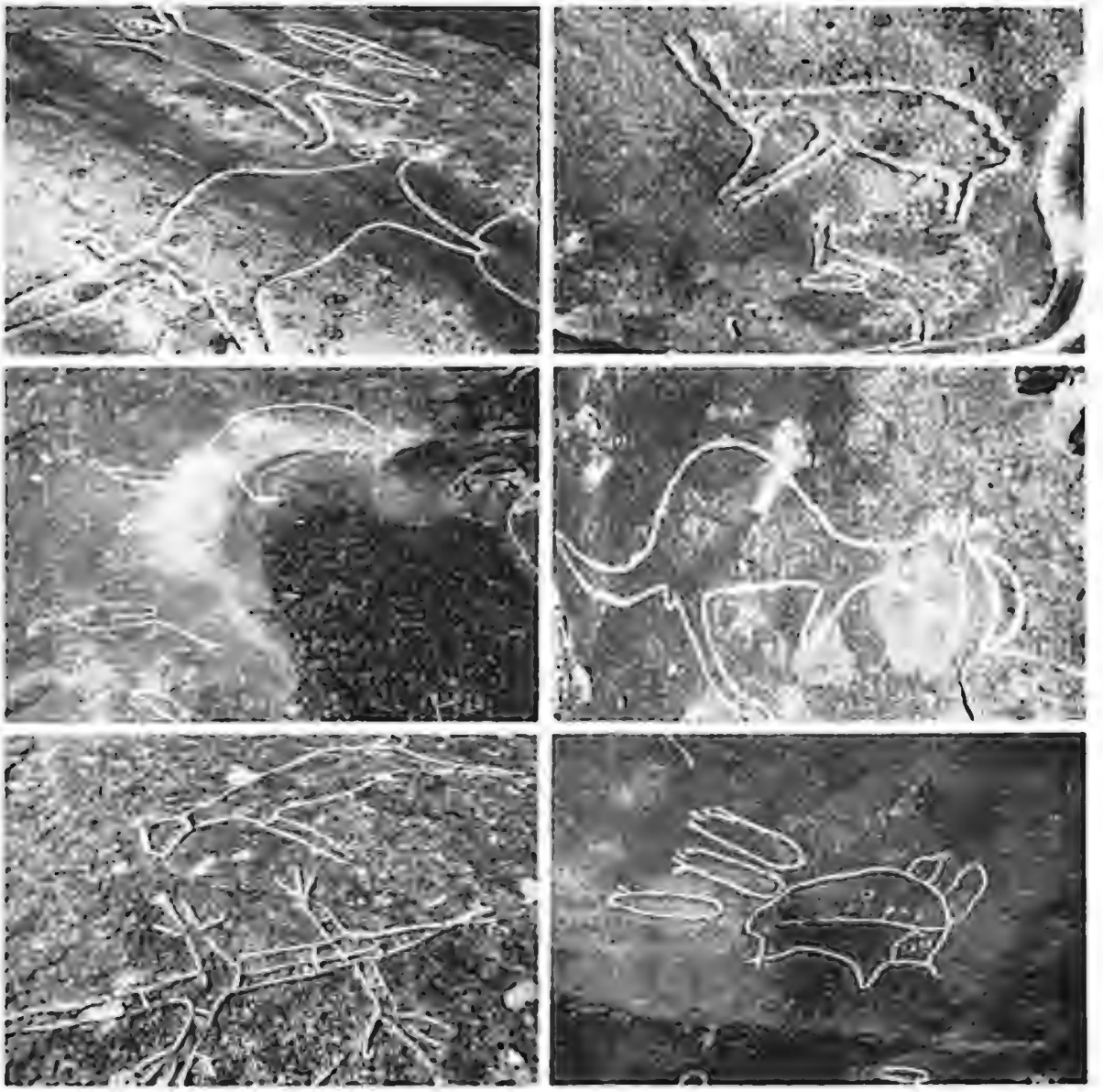
4

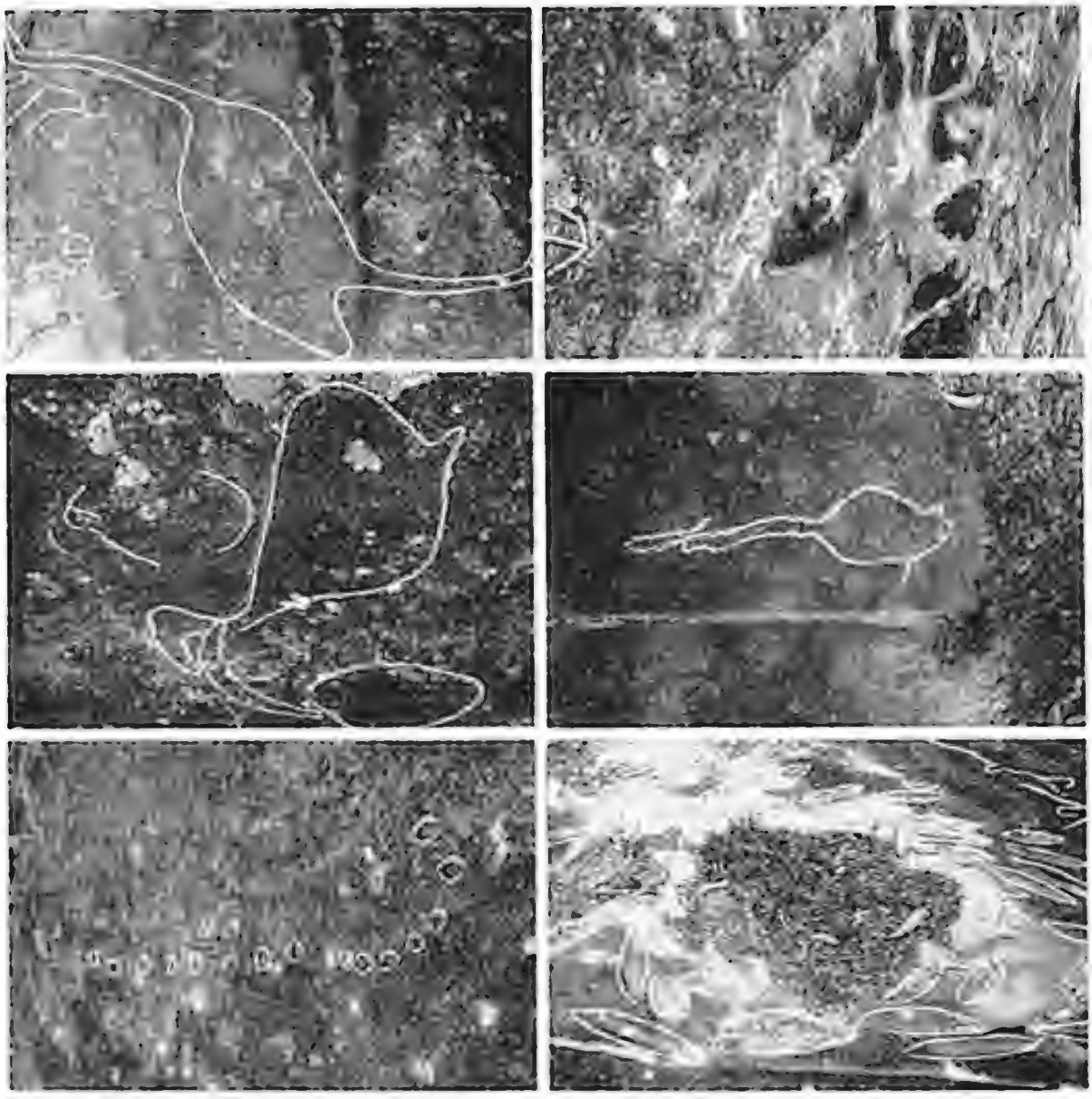
5



6


1
2
3
4
5
6


1
2
3
4
5
6


1
2
3
4
5
6

A NEW SPECIES OF ASCIDIAN (Genus *Culeolus* Herdman, Family *Pyuridae*) FROM THE WEST COAST OF TASMANIA

By PATRICIA KOTT*

(Figures 1-4.)

(Manuscript received 9-12-55.)

SUMMARY

A new species of ascidian *Culeolus littoralis*, from the intertidal region of the coast of Tasmania is described. Its relationship to other species of the genus *Culeolus* Herdman known only from deep waters is discussed.

I. DESCRIPTION

Location.—Between Lighthouse Point and Cutter Rock, Cuivier Bay, west coast Hunter Is., N.W. Tasmania, in intertidal rock cave; growing on and around *Pyura stolonifera* (Heller). The holotype and paratypes of the species are lodged in the Australian Museum.

Externally.—Individuals (Fig. 1) of this species are found clumped together in a similar fashion to *Pyura spinosa* Q. & G. (Kott 1954; *P. leeuwinia* Kott 1952). They are about 2.0 cms long, 1.5 cms wide and 1-1.5 cms high. They may be very irregular in shape, as is usual with those forms which are closely clumped together. The test is tough and leathery but not very thick and it is produced externally into pointed papillae which give the species the general appearance of *Halocynthia hispida* (Herdman) f. *crinitistellata* (Herdman) (Kott 1952, 1954). These papillae are of varying lengths all over the body; however they do not branch as they do in the latter species nor are they in any way modified in length or form in the region around the apertures. Posteriorly the test is produced into root-like processes.

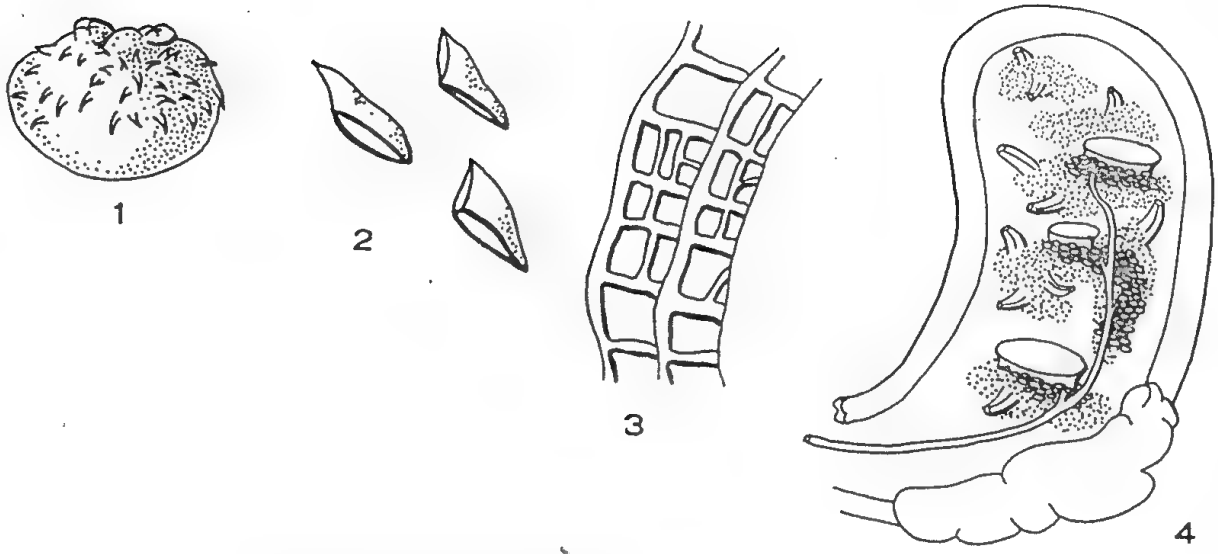
In life the test is rose red in colour, reminiscent of *Microcosmus claudicans* Savigny (Kott 1952).

The external layer of test and the papillae are thickly packed with "mulberry" formed siliceous spicules of varying sizes giving the test its external hardness. These are exactly similar to the spicules found in the test of *P. spinosa* (see above). They project slightly into the internal lining of the siphons and there overlap an area of pointed spines (Fig. 2) lining the distal part of the siphons. The apertures are on adjacent "wart"-like siphons, both anterior.

Internally.—There are 12 compound tentacles, with primary, secondary and tertiary branches; the dorsal tubercle has a large "S"-shaped opening. There are strong muscles radiating out from the siphons but these are limited to the anterior region of the body. Strong circular muscles are present in the same region, deep to the longitudinal muscles. The dorsal lamina is represented by moderately long, pointed languets. There are six branchial folds with a single longitudinal vessel between the folds. Longitudinal vessels are arranged according to the following formula: DL 1(11)1(12)1(14)1(11)1(9)1(5)1E. Stigmata (Fig. 3), however, rarely occur and then never on the folds; when present they are most commonly found in the dorsal and posterior parts of the branchial sac where there may be 2 to 3 regular stigmata in a mesh, but more often they are completely irregular or are absent altogether leaving the open meshes characteristic of the genus. Parastigmatic vessels are usually present. The alimentary canal forms a single open loop around the ventral part of the left side of the branchial sac. There is a large liver in the proximal part of the alimentary canal but no stomach enlargement is present. The anus is fringed by 3 to 4 not very clearly demarcated lobes.

The gonads (Fig. 4) are most distinctive. On the right side of the branchial sac the body wall is covered with irregularly shaped, sometimes branched and ramifying, thick tubular or circular cushion-like ovaries with many oviducts opening from each into the peribranchial cavity. These oviducts are not orientated in any particular direction; some open ventrally, some dorsally, some anteriorly and some posteriorly. Testes are present, superficial to some of the ovaries on the more dorsal and posterior part of the body wall; they are not present antero-ventrally where the ovaries only occupy the body wall. The testes lobes are usually covered by endocarp and are linked by two vas deferens which extend, in parallel, from the most anterior ovary to a point considerably dorsal to any of the oviducal openings. On the left side of the branchial sac the gonads are present in the gut loop, and are much less numerous than on the right side. There is here only one vas deferens opening in the region of the anus; and the testes are absent from the more anterior clumps of ovary. The organisation of the gonoducts is such as to prevent self fertilisation.

*Mrs. W. B. Mather, C/o. Zoology Department, University of Queensland, Brisbane.



FIGURES 1 TO 4.

1. External appearance (nat. size).
2. Siphonal spicules (*x* 400).
3. Portion of branchial sac from between folds (*x* 5).
4. Left body wall showing gonads and alimentary canal (*x* 3).

II. DISCUSSION

The branchial sac and the gonads of this species are quite distinctive. The branchial sac most closely approaches that of *Culeolus wyville-thomsoni* Herdman 1882, in that the meshes are not so completely open as in the other described species of this genus. The condition of the gonads with numerous oviducts and common vas deferens is similar to that described by Herdman for *Culeolus recumbens* Herdman 1882.

The species has not the usual stalk, nor were any spicules detected in the branchial sac; but although the stalk has without exception been present in previously described forms, the spicules are occasionally absent (*C. sluiteri* Ritter, Van Name 1945), and it is probable that these characters are variable within the genus. The present littoral species, therefore, may be considered as morphologically intermediate between *Culeolus* and *Pyura*, and less differentiated from *Pyura* than other species of *Culeolus*, all recorded from water deeper than 600 fms, with the exception of one species off the coast of Malaya taken in 204 m.

The wide meshed branchial sac has previously been considered characteristic of deeper water forms.

III. ACKNOWLEDGMENTS

Acknowledgment is gratefully made to Miss I. Bennett, Zoology Department, University of Sydney, who collected the specimens and made them available to me for description and identification; to the Trustees of the Science and Industry Endowment Fund from whom I am in receipt of a research grant; and to Professor Stephenson, Zoology Department, University of Queensland, Brisbane, for making available to me the facilities for this work.

IV. REFERENCES

Herdman, W. A. 1882. Report on the Tunicata collected during the voyage of H.M.S. *Challenger* during the years 1873-1876. Part 1, Ascidiae simplices. In Thompson, C. W. and J. Murray, *Rep. Sci. res. Chall. Exped.* Zool. Edinburgh 6: 296 pp., 23 figs., 37 pls.

Kott, P. 1952. The Ascidians of Australia, Pt. 1: Stolidobranchiata Lahille and Phelobranchiata Lahille. *Aust. Journ. Mar. Freshw. Res.* 3 (3): 206-333, 183 text figs.

Kott, P. 1954. Ascidians *in* Tunicata, *B.A.N.Z.A.R., Expedition reports.* Series B. 1 (4): 123-182.

Van Name, W. G. 1945. The North and South American Ascidians. *Bull Amer. Mus. Nat. Hist.* 84: 1-476. 31 pls., 327 figs.

Sydney: A. H. Pettifer, Government Printer—1956

VARIATION IN THE AUSTRALIAN KINGFISHERS (AVES: ALCEDINIDAE)

By Allen Keast

(Figure 1)

(Manuscript received 17.12.56)

The present work has as its objective a study of infraspecific variation and speciation in the Australian Alcedinidae.

Species and Range: There are ten species of kingfishers in Australia, and they fall into five genera. Dominant, and the most widespread, are the forest kingfishers (*Halcyon*), of which there are four species. Two "giant" kingfishers (*Dacelo*) do much of their feeding on the ground. Two small, long-billed, short-tailed river kingfishers (*Alcyone*), single members of the New Guinea genera *Tanysiptera* (long-tailed kingfishers) and *Syma*, make up the rest of the fauna.

In terms of distribution and habitat the kingfishers separate out as follows: *Syma torotoro* and *Tanysiptera sylvia*, confined to rain-forests and scrubs of the north-eastern corner of the continent; *Alcyone pusilla* and *Halcyon chloris*, mangroves and inlets of the north; *Halcyon macleayi*, rain-forests and sclerophylls of the east; *Alcyone azurea*, rivers of the east and north; *Halcyon sancta*, migratory species (in the south) with a wide range, but concentrating for breeding in the better sclerophylls and savannahs; *Dacelo novaeguineae* and *Dacelo leachii*, southern and eastern sclerophylls and savannahs in the case of the former and northern savannahs in the latter; *Halcyon pyrrhopygia*, an inhabitant of the dry interior of the continent. Where more than one kingfisher occurs over a section of the continent different vegetation associations are occupied or food requirements are distinct. In the south-eastern sclerophyll forests, for example, the forest *Halcyon sancta* and *Dacelo novaeguineae* obviously have different ecological requirements (the former is much smaller, having a wing-length of 90-100 mm, the latter being 215-230 mm). The water kingfisher, *Alcyone azurea*, obtains its food exclusively by diving.

The bulk of Australian species has obviously had a northern origin, in several instances in the not too distant past. *Tanysiptera sylvia* and *Syma torotoro* are New Guinea species with a mere toehold in the tropical north-eastern corner. *Alcyone pusilla*, another northern species, is restricted to the mangrove-fringed shoreline of the Australian north coast. *Halcyon sancta*, extending widely over Australia, and *H. chloris* of the northern mangroves, are members of superspecies extending from Asia to the south-west Pacific. Both are migrants in Australia, suggesting that their occupation of the continent is too brief for them to have become adapted to the temperature and food conditions of winter in the south. *Halcyon macleayi*, an eastern and northern forest species in Australia, is also a migrant in the south of its range.

Species endemic to Australia and that obviously originated here are *Halcyon pyrrhopygia* and the two members of the genus *Dacelo*. *H. pyrrhopygia* is perfectly adapted to life in arid places, whilst both kookaburras (*Dacelo* spp.) extend well inland. *Alcyone azurea* has presumably had a long occupation of the continent for, despite its belonging to a tropical group, there is no migration even in cold areas.

Material and Methods: Specimens in the following museums were used in the work: American Museum of Natural History, New York (which houses the Mathews "types"); Australian Museum, Sydney; National Museum of Victoria, Melbourne; South Australian Museum, Adelaide.

Localities from which specimens of the various species have been seen are listed in the taxonomic section. Measurements of specimens were made as follows: *Wing-length*—from angle of wing to tip, straightened along the rule; *Bill-length*—from tip to the base of the first feathers; *Tail-length*—from base of centralmost two feathers to the tip.

The approach in the present work has been to study geographic variation in series of adult male specimens and to confirm any trends with the adult females. Detailed measurements of the former are set out in the body of the text. In the case of migratory and nomadic species only specimens collected during the breeding season have been used. Specific descriptions, plus those of sex and immature forms, are not given as they have been amply covered in the various standard works on Australian ornithology. It may be mentioned,

however, that with the exception of *Dacelo leachii* and *Syma torotoro*, sexual dichromatism is negligible in Australian kingfishers. The sexes, moreover, tend to be of the same general size (judging from wing lengths) as will be seen from the following:—

	Males	Females
Halcyon sancta (Sydney area) (15 males, 8 females)	90-98 (94) mm	88-96 (94) mm
H. macleayi (N.S.W.) (10 and 6)	88-96 (93) mm	92-95 (94) mm
Dacelo novaeguineae (N.S.W.) (10 and 5)	215-230 (222) mm	218-227 (223) mm
Dacelo leachii (Cape York) (5 and 4) ..	195-203 (198) mm	195-205 (199) mm

Immature kingfishers are, as a rule, readily recognisable on plumage characters. Buff edging to the wing coverts and feathers of the forehead occurs in the young of *Halcyon*, and a general drabness is typical of most species at this time. However, the significance of the breast colouring and ventral barring in the individually variable *Dacelo leachii* requires proper study from the age viewpoint.

When geographic variation in a species has been detected special attention has been given to ascertaining whether it was merely clinal variation (gradual change of character from one end of a range to another) or whether isolation had been involved in its development. Isolation is, of course, the first step in the process of speciation. Attention has also been given to factors governing distribution and to the nature of distributional barriers, present and past. Forms with the potential of developing into species in the future are discussed. Finally, recommendations are made as to how infraspecific variation may best be treated nomenclatorially.

Alcyone azurea (Latham) 1801. (Azure Kingfisher).

This little river kingfisher ranges along the north coast from Derby in the north-west to Cape York, and thence south to Tasmania and the Mount Lofty region of South Australia. In the south-east it extends inland along the rivers. Beyond Australia the species has an extensive distribution in New Guinea and the contiguous islands.

A. azurea is a true water kingfisher, living along rivers and small creeks and obtaining its food by diving. Minor range gaps are to be expected where waterways are absent, although over much of the north of the continent it inhabits mangroves, a reasonably continuous habitat.

Geographic variation: Two basic types occur: south-eastern Australia (*azurea*) and north Australia (Cairns-Kimberleys) (*pulchra*). The latter is distinguished by being a deeper (royal) blue dorsally and having the breast more richly coloured (deep chestnut in north-western birds), and with purplish-blue extending down the flanks, as has been noted by Sharpe, Hartert, Mathews (1918) and North (1909).

Birds from Tasmania, Victoria, and the Mount Lofty Ranges, fit into the Sydney series. The deeper blue dorsal colouring of the northern birds is first suggested in odd individuals from northern New South Wales (specimens in American Museum of Natural History), suggesting that, so far as dorsal colouring is concerned, the change from southern to northern type is clinal. All Cairns birds have the richly coloured back, as do those from Cape York. Three McArthur River birds and one from Groote Eylandt (Gulf of Carpentaria), have drabber (blackish) back and the rump a paler blue than typical northern birds and they approach the southern birds in these characters. Again, birds from southern New Guinea are a shade deeper blue on the back than those from northern Australia.

In contrast to the colouring of the dorsal surface that of the ventral surface only becomes really richly coloured (deep chestnut) in birds from the Northern Territory and Kimberleys.

A. azurea has a south-north cline of decreasing size, as will be seen from the following wing-length measurements for adult males: Mount Compass, South Australia (1), 75 mm; Glenelg River (1), 75 mm; Tasmania (4), 79-82 mm (mean 81); Melbourne area (6), 74-80 mm (76); Sydney area (16), 75-80 mm (77); Richmond River—Brisbane (6), 76-79 mm (77); Cairns (8), 76-79 mm (73); Cooktown (the "type"), 75 mm; Cape York (5), 73-75 mm (73); McArthur River (3), 71-74 mm (73); Groote Eylandt (1), 72 mm; Melville Island (1), 74 mm; coastal Northern Territory (5—two from King River, one each from Port Essington, Alligator River, Victoria River), 72-74 mm (73); Parry's Creek (3—including "type"), 71-73 mm (72); Napier Broome Bay (2), 72 and 75 mm; Derby (4), 72-75 mm (74). Five males from southern New Guinea (Fly River and Milne Bay) have wings ranging from 73-75 mm (74).

Northern birds also have shorter tails, *viz.*: Tasmania, 32-37 mm (35); Melbourne, 32-37 mm (34); Sydney, 32-36 mm (34); north-eastern New South Wales, 33-36 mm (34); Cairns, 31-34 mm (33); Cape York, 26-30 mm (28); coastal Northern Territory, 28-31 mm (30); Parry's Creek and Napier Broome Bay, 30-32 mm (31); Derby, 28 and 29 mm.

North-western birds have shorter bills than the eastern stock, as pointed out by Hartert (see Mathews). There is a great deal of individual variability in the bill of kingfishers, hence large series would be necessary to demonstrate accurately the extent of this difference.

At one time or another the following races have been proposed in Australia: *diemenensis* Gould 1846 (Tasmania); *victoria* Mathews 1912 (Frankston, Victoria); *azurea* (Latham) 1801 (Sydney); *mixta* Mathews 1912 (Cooktown, Queensland); *pulchra* Gould 1846 (Port Essington); *alisteri* Mathews 1912 (Parry's Creek). The names *victoria*, *mixta*, and *alisteri*, were subsequently placed in synonymy by their author. Tasmanian birds do not differ in colour from those of the mainland, as Gould originally supposed, but they are, in fact, slightly larger, representing the endpoint of a size cline. They should not bear a subspecific name.

The form *pulchra* is a distinctive one. The question arises as to whether the name should be restricted to north-western birds (chestnut breasts), or apply to northern birds as a whole (backs a deep blue, small size), as Mack (1953) has done. The writer feels, however, that the proper course is to recognise three races, an eastern and southern one (*azurea*), a north-eastern one (which will take the name *mixta* Mathews 1912), and a north-western one (*pulchra*).

The north-western and eastern populations of *A. azurea* are apparently isolated. Despite absence of differentiation the Tasmanian and Mount Lofty (South Australia) populations are probably isolated from the main eastern stock. Likewise the New Guinea-Aru populations (three New Guinea races are listed by Mayr, 1941), are presumably isolated from those of Australia.

Alcyone pusilla (Temminck et Laugier) 1836. (Little Kingfisher).

This small mangrove inhabitant extends along the north coast from about Hinchinbrook Island to Port Keats. It is a sedentary species.

Geographic variation: There are two colour-forms. Hinchinbrook-Cairns birds (*halli* Mathews 1912) are a deep royal blue above, with a greenish-blue developed to a variable extent on the forehead. North-western birds (Melville Island, Anson Bay, King River) are distinctly paler blue above (*ramsayi North* 1912). Cape York birds (given the name *yorki* by Mathews 1918), and those from Groote Eylandt, have hybrid characteristics, with individuals matching each colour form and others being intermediate. Thus two Cape York birds resemble those from Melville Island, four are intermediate, and one is purplish-blue above (specimen from Somerset in the far north). The two Groote Eylandt birds are intermediate.

Birds from southern New Guinea are an even deeper purplish-blue above than Cairns birds. It would seem likely that the richly-coloured Somerset bird derives its characteristics from the New Guinea race (*i.e.*, there is gene flow across Torres Strait) rather than from the Cairns one well to the south.

Wing-length measurements for adult males are: Hinchinbrook (1), 58 mm; Cairns (9), 53-56 mm (54); Cape York (4), 51-53 mm (52); Daru and Wassi Kussa River, New Guinea (5), 50-53 mm (51); Melville Island (5), 51-53 mm (52); King River (3), 51-53 mm (52). Tail-lengths reflect the wing-length changes, the Hinchinbrook male measuring 22 mm; Cairns birds 20-21 mm (21); Cape York, all 20 mm; southern New Guinea, 18-20 mm (19). Thus a south-north cline of decreasing size is indicated.

Syma torotoro flavirostris Gould 1850. (Yellow-billed Kingfisher).

In Australia *Syma torotoro* is restricted to the northern tip of Cape York. It is described as an inhabitant of the tropical brushes by MacGillivray (1918). However, Thorpe (1909) says that it frequents the dry, open belts of timber inland and is seldom met with in the dense coastal scrubs.

Geographic variation: The Australian race constitutes a distinctive isolate (on colour grounds). Wing-length measurements of adult males (5) are: 75-78 mm (76), and females (4): 74-76 mm (75).

S. torotoro has apparently been some time in Australia for it is difficult to say from which of the races inhabiting southern New Guinea the Australian form *flavirostris* is derived. The race *pseutes* from the Oriomo is much more rufous ventrally, this colour extending up towards the chin and right down over the abdomen, whereas in *flavirostris* the rufous is only strongly developed on the breast and upper abdomen. The Oriomo birds are dark green above, much brighter than the drab colouring of *flavirostris*. Specimens of the form *brevirostris* from the Wassi Kussa River have the ventral red as extensive as in *pseutes* but it is paler; the back is drab like *flavirostris*. A pair of birds from the Aru Islands have the ventral colouring of the Oriomo *pseutes* (*i.e.*, rich and extensive) with the back somewhat drab (but not as much so as in the Wassi Kussa birds).

Dacelo novaeguineae[1] (Hermann) 1783. (Kookaburra).

The Kookaburra is an inhabitant of the sclerophyll and savannah woodlands of the eastern section of the continent from west of Adelaide to Cape York. Whilst it extends through the drier country in the south where the range overlaps that of *D. leachii* it is essentially an inhabitant of the coastal mountains. For example, Thomson (1935) states that in Cape York *D. novaeguineae* is dominant in the hilly country of the central range of the Peninsula (the only place where the southern *Gymnorhina tibicen* and *Strepera graculina* also occur), whilst *D. leachii* is the common species elsewhere (drier areas). The susceptibility of *D. novaeguineae* to heat and drought (Austin 1909, and others) might be noted: possibly this places it at a competitive disadvantage with *D. leachii* in the north of the continent.

The Kookaburra has been introduced to both the south-west of the continent (Serventy and Whittell 1951) and Tasmania (Sharland 1945), in both of which the species is now well-established.

Geographic variation: This is individually a variable species, though the sexes are alike in colouring. Adults have been seen from Adelaide (few), Melbourne and Sydney (each good series), Clarence and Richmond Rivers, Leeton and Mossgiel (single birds), Cairns (series), Cooktown, Cape York (series). The species does not appear to vary geographically in colour.

Measurements for adult males from various parts of the range are:

		Wing Length (mm)	Tail Length (mm)
Melbourne	(6)	213-225 (220)	154-162 (160)
Sydney	(10)	215-230 (222)	152-162 (154)
Cairns	(6)	209-220 (215)	147-154 (151)
Cooktown	(1)	200	148
Cape York	(5)	192-210 (202)	145-155 (149)

It will be seen that whilst there is minor size variation (as judged by wing-length) from Melbourne to Cairns, there is a sharp drop as between the Cairns and Cape York populations at the northern extremity of range. The bill of Cape York birds is also shorter than in birds from the south. The difference between Cairns and Cape York birds is such as to be strongly suggestive of isolation (former or continuing) between them.

The small northern form of *Dacelo novaeguineae* must be recognised nomenclatorially. As, however, only one bird from Cooktown has been available to me I am unable to say what the southern limits of the form are. This is important as the name *minor* Robinson 1900 was given to Cooktown birds and *mclennani* North 1911 to those from Cape York. The name *minor* is the older and, since the single Cooktown bird is quite small, I recommend its usage pending further investigation. Mathews' "*tregellasi*", given to the Victorian birds, must be reduced to synonymy.

Dacelo leachii Vigors and Horsfield 1827. (Blue-winged Kookaburra).

This species ranges across the north of the continent (where there is savannah woodland) from about Toowoomba, south Queensland, to south of Carnarvon in the mid-west (see Fig. 1). Ninety-Mile Beach, to the south of the Kimberleys, apparently forms a distributional barrier in the west. Beyond Australia *D. leachii* ranges along the south coast of New Guinea from the Mimika to Port Moresby, the island stock being divisible into two races (Mayr 1941).

Dacelo leachii is a sedentary species.

Geographic variation: *D. leachii* is most variable, both individually and geographically. Much of the individual variation is apparently associated with age. Sexual dimorphism in colour is pronounced in *D. leachii*, the tail of males being blue (above) and those of females cinnamon with blue barring.

At the geographic level *D. leachii* is divisible into many races. The coloration of the different parts of the body varies independently as follows:—

(*a*) Back: This is dark chocolate brown in birds from Melville Island and adjacent parts of the Northern Territory, slightly paler in Cape York birds, and fairly dark in birds from Cairns and Groote Eylandt. Populations elsewhere are distinctly paler and could be described as mid-brown, though there is individual variability. New Guinea birds (Hall Sound, Port Moresby) are much darker dorsally than any in Australia and sometimes have a "bluish" tint through the mid-back.

[1] Several authors (recently Condon, Mack) have stressed the inaptness of *novaeguineae* (see Streseman) as the specific name for the Kookaburra, since it does not occur in New Guinea. It is a pity, after such long usage, to drop *gigas* in favour of *novaeguineae*. A recent paper (Lysaght 1956) has shown that the type specimen of Sonnerat did, in fact, come from eastern Australia.

(*b*) Breast: This is more reddish in Melville birds than those from elsewhere. Specimens from Port Essington and Port Charles are also richly coloured. The breasts are paler ("ochraceous") in birds from the southern extremity of range in the west (Carnarvon, Roeburn, Yalbalgo, Boolathanna). Kimberley birds, and those from the drier areas of the Northern Territory are most variable, and in a sense intermediate since about two-thirds of those examined had breasts of intermediate tones, a third had ochraceous ones. Some, especially the few from Parry's Creek, were quite pale.

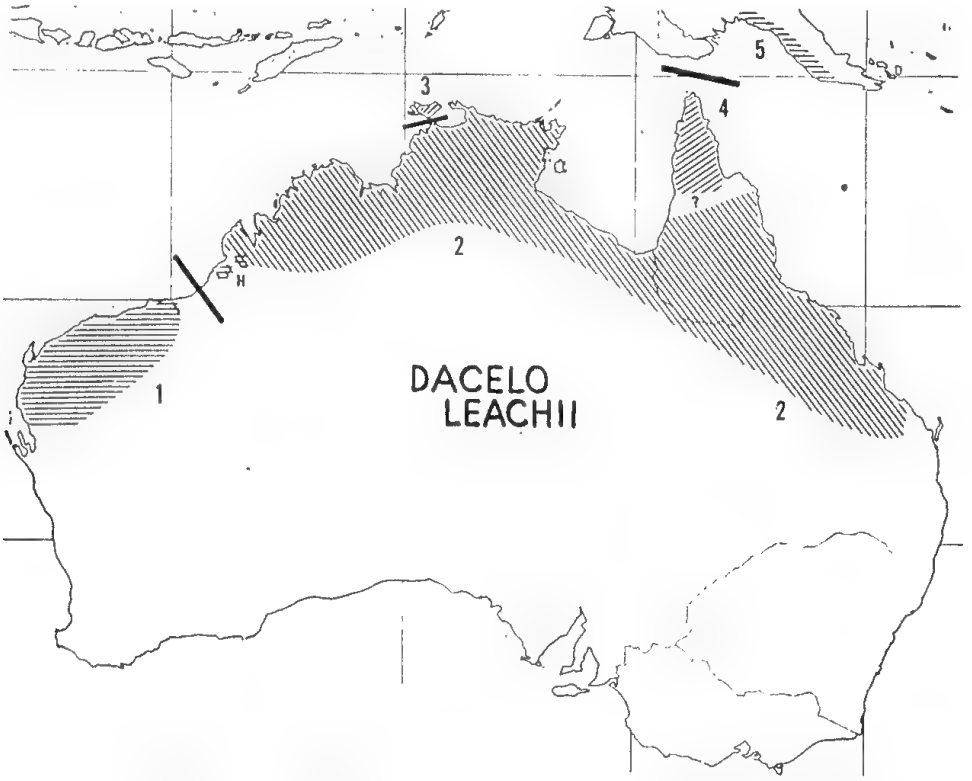


Fig. 1.—Races of the Blue-winged Kookaburra (*Dacelo leachii*): (1) *cliftoni*, (2) *leachii leachii*, (3) *cervina*, (4) *kempi*, (5) *intermedia* and *superflua*. The heavy black lines indicate distributional barriers.

Eastern birds are pale ventrally, the colouring in birds from Cairns and further south being best described as pale buff. Normanton and McArthur River individuals are almost as pale. The Cape York series is, however, variable. Two out of nine birds have "ochraceous" breasts and the others are pale. New Guinea birds from Hall Sound and Port Moresby are very pale ventrally.

Whilst the individual variation in breast colouring would suggest that it has an age basis there is some sorting out geographically.

(*c*) Barring on ventral surface: This is strongly developed in eastern and northern birds, faint or absent in birds from the Kimberleys and Hamersley regions. To some extent it seems to be associated with age.

(*d*) Blue on wing: The intensity of the coloured area varies somewhat, being brightest in the north (Melville Island, Northern Territory coastal, and Cape York).

In New Guinea birds (Hall Sound and Port Moresby) it is of a slightly richer and deeper shade.

(*e*) Colouring of top of head: This, in the main, reflects the width of the brown stripe down the centre of the individual feathers. Where it is broad the birds are brown-headed and where narrow, white. Tone of the brown varies, in addition, with the colouring of the back. Over the greater part of the range the top of the head could be said to be "mid-brown" in colour and decidedly streaked. In the far north (Cape York, coastal Northern Territory and especially Melville Island) the colouring is a uniform dark chocolate brown. In the Hamersley populations (south of Ninety-Mile Beach) in western Australia the top of the head approaches white in colour.

Wing-length measurements of adult males from various parts of the range are: South and central Queensland (Brisbane River, Fitzroy River, Duaringa, Double Island)—6 birds, 204-216 mm (208); Cairns (4), 197-206 mm (203); Cooktown (1), 190 mm; Cape York (5), 195-203 mm (198); Normanton (5), 192-200 mm (199); Groote Eylandt (1), 187 mm;

Melville Island (4), 178-184 mm (182); Port Essington (3), 180-185 mm (183); other localities in Northern Territory (Port Keats, Katherine River, Daly River, King River—8), 188-196 mm (191); Kimberleys (Parry's Creek, Wyndham, Ord River, Derby—10), 190-196 mm (193); Hamersley area (6), 192-203 mm (197); New Guinea (Goldie River, Hall Sound—5); 202-211 mm (208).

Tail-length measurements reflect those of the wings, being greatest in birds from south-central Queensland (mean 129 mm), with a cline northwards to Cape York (mean 125 mm), and smallest in the Melville Island stock (mean 108 mm), with a cline of increasing size southwards to the Hamersley region (mean 128 mm). The largest bills occur in south-central Queensland birds (mean 72 mm), with the mean of the Cape York stock 64 mm, and the smallest on Melville Island and adjacent coast (57 mm). Mean bill length of the Hamersley stock is 66 mm.

Summary of geographic variation in D. leachii: It is obvious that there are quite a number of characters varying independently in this species and that, since the species extends through the drier country, most variation must be clinal.

The following geographic forms can be recognised, and their range is plotted on the text figure:

(1) Hamersley region, mid-western Australia (*cliftoni*).—This is a distinctive isolate, readily recognisable by its white head. The presence of one or two "pale-headed" birds in the Derby series indicates that there is slight intrusion of Hamersley genes to the north.

(2) South Queensland to the Gulf of Carpentaria, Northern Territory and Kimberleys (*leachii leachii*).—This is the generalized form of the drier parts of the species range. There is clinal variation, including a south-north cline of decreasing size and darkening of the upper parts in areas of high rainfall (Cairns).

(3) Melville Island and narrow coastal strip on adjacent mainland (*cervina*).—This is characterized by the very dark brown upper parts and dark head, also by very small over-all size and bill. It is undoubtedly connected with *leachii* by a cline but it must be a steep one. The question arises as to whether to include the Port Essington-Port Keats birds with those from Melville Island (which seems the better course) or stress the differences of the former (smallness, darkness, reddish breast) by keeping it apart from mainland stock. The impression gained from studying the material is that the Melville stock is partly isolated but with gene flow outwards on to the adjacent coast. The "steep" colour changes presumably reflect the precipitous reduction in rainfall from the coast inland in this area of the Northern Territory. The darker mainland birds, *e.g.*, Port Keats, would then be no more than local colour forms.

(4) Cape York (*kempi*).—This bird is fairly small, is dark above but tends to be pale ventrally. Presumably its similarity to *cervina* dorsally reflects like environments in Cape York and Melville Island.

(5) Southern New Guinea (*intermedia* and *superflua*).—The former is much darker dorsally than *cervina* or *kempi* and the blue of the wing is brilliant. It is a large form (wings of male, 202-212 mm, as against 197-203 mm for Cape York; tails 129-132 mm compared to 121-128 mm). New Guinea birds are isolated from those of Australia.

Variation in *D. leachii* may be summed up by saying there are two good isolates (*cliftoni* and the New Guinea *intermedia-superflua*) a partial isolate on Melville Island, and marked clinal variation over the rest of the range.

The number of "races" described in *Dacelo leachii* stems from its marked variability and the fact that its colour is, apparently, readily influenced by physical environment. The following may now be placed in synonymy: *occidentalis* Gould 1870 (Derby); *mungi* Mathews 1912 (Mungi); *nana* Mathews 1912 (Melville Island); *macarthuri* Mathews 1918 (McArthur River).

Halcyon pyrrhopygia Gould 1840. (Red-backed Kingfisher.)

This species is distributed through the inland areas of the continent, extending to the sea in the west, north, and north-east, where the dry country reaches the coast. It does not occur in Tasmania. The habitat could be described as savannah, mallee, and mulga. The range is continuous.

H. pyrrhopygia is a migrant in the south, returning in September to Mudgee, Cobborah, Mossgiel and Broken Hill in western New South Wales, and not being seen after February (Mossgiel, N.S.W., and Laura, S.A.)—see North (1909). Like many other inhabitants of the arid interior the number of birds breeding in an area varies with the season and nomadism is well developed at other times of the year.

Geographic variation: Specimens have been seen from the following localities: Victorian mallee; western New South Wales (Narrabri, Moree, Byrock, Cobborah); Queensland (Charleville, Nogoa River, Coopers Creek, Normanton, Cape York); Northern Territory (Hamilton Bore, Love's Creek, Wantapilla Swamp, Finke River, in the central areas and

Brocks Creek, Patrick River, Daly River, McArthur River, in the north); Western Australia (Parry's Creek, Forrest River, Napier Broome Bay, Derby, Marngle Creek, Point Cloates, Geraldton, Marble Bay, Carnarvon, Kalgoorlie).

Geographic variation is negligible. Birds from Parry's Creek (Mathews' "*obscurus*") are not duller above than those from the south-eastern extremity of range, as stated by Mathews. The chestnut of the rump is actually slightly deeper (freshly moulted birds) in some five specimens of the former. In immature birds from Parry's Creek the characteristic pale tips to the wing feathers are chestnut, compared to buff in Normanton birds of similar age (the only area from which comparable material has been seen). Mathews named the birds from Cape York as a race and subsequently reduced them to synonymy. This was the correct course as other series share the characters attributed to them.

Wing-lengths for series of adult males from various parts of the range are: Port Augusta (4), 102-107 mm (105); Victorian mallee (6), 102-106 mm (103); western New South Wales (9), 100-108 mm (103); Dawson River (1), 103 mm; Port Denison (2), 106 and 107 mm; Normanton (3), 98-102 mm (100); McArthur River (1), 101 mm; Cape York (2), 98 and 99 mm; central Australia (4), 101-104 mm (102). Material from the western section of the continent is poor: Kellerberin (1), 101 mm; Geraldton (1), 99 mm; Point Cloates (1); 103 mm; Carnarvon (4), 98-106 mm (101); Derby (1), 102 mm; Parry's Creek (4), 97-102 mm (100). It will be noted that there is a suggestion of a minor south-north cline of decreasing size in the east.

No races can be recognised in *Halcyon pyrrhopygia*.

Halcyon macleayi Jardine and Selby 1830. (Macleay Kingfisher.)

This is a species of the coastal and near-coastal sclerophyll and rain-forest in the east and of savannah woodland in the north. The range extends from about the Macleay River (one record for Sydney) to Cape York and thence westwards along the north coast to about Derby. Presumably distinctive eastern and north-western forms are isolated. However, MacGillivray (1914) states that he noted the species all the way down the Cloncurry River, at the head of the Gulf of Carpentaria.

The species is generally considered to be migratory in the south-east, rarely being noted in the southern parts of its range during the winter. There are, however, several birds from New South Wales in the American Museum Collection collected between May and August (Mayr 1937). North (1909) states with respect to New South Wales: "The birds are chiefly migratory, arriving very early in September, a few remaining during the winter." Mayr gives the extra-Australian winter range as Kei Islands, eastern New Guinea (east of Mimika River and Astralobe Bay), Fergusson Island, the Trobriands, Woodlark, Misima and Tagula, and New Britain. It is apparently a rare bird on the east coast of New Britain for during nearly a year's stay in the Jacquinot Bay area during the war the writer saw only odd birds on perhaps a dozen occasions. The first record was 15 April and the last 1 August.

Geographic variation: Australian birds, collected during the spring and summer, fall into two colour series—those from the north-west and east of the continent respectively. Variation in *H. macleayi* is in two main characters, size of the "white panel" on the wing and tone of blue of the dorsal surface, as has been shown by Mayr (1937).

The white area on the wing is much more extensive in north-western birds than in eastern, *e.g.*, out of eight birds from Melville Island the white along the inner edge of the primaries starts on primary 4 in the case of five birds, and P. 5 in three. This is a fair sample of the north-western populations. By contrast, in eleven birds from New South Wales it starts on P. 5 and in three on P. 6. Cairns birds are similar, the white starting on P. 5 in ten birds and P. 6 in three. Only three spring adults have been seen from Cape York. In one the white starts on the fourth primary, in one on the fifth, and in the other it becomes pronounced only on P. 6. It starts on the fifth primary in a single spring bird from Russell Island, Torres Strait.

Comparing the breeding race in New Guinea (*elisabeth* (Heine) 1883) with the birds from eastern Australia Mayr (1937) has written: "The white bar across the wing is usually (but not always) much more pronounced, and starting on the third, instead of the fifth primary." It will thus be seen that the population of *H. macleayi* in north-western Australia approaches the New Guinea type in the wing character.

Melville Island birds are bluer (not so "green-blue") on the back than eastern birds. Occasional individuals are markedly bluer still, the colouring being as rich as in *elisabeth*. These are an October male from South Alligator River (type of Mathews' "*distinguendus*"), a May male from Palmerston, and an August male from the Margaret River.

Wing-length measurements for adult males of *H: macleayi* collected during the breeding season in various parts of the range are: New South Wales (10), 88-96 mm (93); Dawson River (1), 88 mm; Cairns (8), 88-94 mm (92); Cape York (2), 87 and 89 mm; Torres Strait (1), 95 mm; coastal Northern Territory (5), 86-90 mm (88); Melville Island (6), 86-91 mm (88). The differences in wing-length as between the far south and the north-east are reflected in females, nine from New South Wales averaging 93 mm and three from Cape York 87 mm. Mayr, using the same method of measuring as the writer, gives the following measurements for the New Guinea race *elisabeth*: adult males (5), 89-93 mm (91); adult females (5), 88-97 mm (92).

Variation in *H. macleayi* may be summed up by saying that the breeding birds of New Guinea and the north-west of Australia are characterized by a large white wingpatch and blue dorsal colouring and birds from eastern Australia by a small white wingpatch and blue-green colouring on the back. The New Guinea (breeding) birds (*elisabeth*) differ from the north-western ones in tending to be an even richer blue on the back and, apparently, slightly larger.

The two major types of *H. macleayi* must have arisen in isolation, and there is probably little gene flow between them today. The New Guinea stock is also largely isolated.

From the nomenclatorial viewpoint there is the alternative of recognising only two forms in *H. macleayi* (lumping *elisabeth* under the nominate *macleayi*) or admitting three. The latter is by far the better course, hence the races of *macleayi* will become as follows: *macleayi, incincta Gould* 1838, and *elisabeth*. I agree with Mathews that the various additional forms described from the Northern Territory should be sunk into synonymy, *i.e.*, *distinguendus* Mathews 1912, *publa* Mathews 1912, *caeruleus* Ashby 1914. Likewise, there is no basis for *barnardi* Campbell 1911 (Cape York).

Halcyon sancta Vigors and Horsfield 1827. (Sacred Kingfisher.)

This species has almost an Australia-wide range. The habitat is sclerophyll and savannah woodland (especially along streams), and mangroves. It extends seasonally well out into the interior, where there are timbered watercourses. *H. sancta* is rare in Tasmania, being reported only at long intervals in the south (Sharland 1945).

Migration is marked in southern populations, the birds wintering in northern Australia, New Guinea, the Solomons, Bismarcks, and Moluccas. Dates of arrival and departure in the south of the continent are as follows:

Inland New South Wales (Mossgiel)—September and February (Bennett 1909).

Sydney area—end of August or early September and mid-March (North 1909); mid-September and February (Gilbert 1935).

Tasmania (north)—October (Dove 1918).

South-western Australia—first half of September and early March (Serventy and Whittell 1951).

Campbell and White (1910) record migrants striking the lights of ships off the Capricorn Islands in the first half of October. Not all members of *H. sancta* migrate, odd birds being at least as far south as Sydney in the east and in the south-west corner of the continent during winter months.

In the southern parts of the continent migration is regular and birds return to the same valleys and creeks from year to year to breed. In dry parts of the Northern Territory, however, it would appear that they only move into certain areas after the onset of the summer monsoon. Jarman (1944) records this with respect to the Banka Banka area (400 miles north of Alice Springs), the birds arriving with the first rains in December (1942), breeding, and departing again in February. In western New South Wales Bennett states that the length of stay in the area varies with the season.

With regard to dates of arrival at the wintering grounds Mayr (1945) records the birds arriving in the Solomons and Bismarcks during February and March and departing again in September-October. The writer witnessed the arrival of the first migrants at Jacquinot Bay, New Britain, on 18 March 1945. By mid-April the species was dispersed all along the shoreline. The numbers appeared to fall away as early as the end of June. *H. sancta* was a common bird about Port Moresby during the winter of 1944.

Mayr (1944) has discussed the close relationship of *H. sancta* to *H. australasia* of the East Indies, and concludes that the former is but a recent arrival in Australia (as its migratory habits would suggest). It has subsequently invaded New Zealand and the Loyalty Islands from Australia, where it has since formed weak races.

Geographic variation: Although there are extensive Australian collections of this species, since it is a migrant only specimens taken during the breeding season can be used in the study of geographic variation. This reduces the amount of material appreciably. Good series of spring-summer birds have been seen from southern Victoria, Sydney and central New South Wales, south Queensland, south-western Australia, reasonably good series from Normanton and Parry's Creek, and smaller numbers from Cairns, Cape York, Carnarvon, Derby and the coastal Northern Territory.

Halcyon sancta is individually a very variable species. This applies particularly to the ventral surface and nuchal collar, in each population individuals ranging from pale buff to deep ochraceous over these areas. To what extent age is involved here is unknown.

There is a suggestion of a geographical sorting-out of *Halcyon sancta* so far as the colour of the nuchal collar and under-surface is concerned. These parts of the body tend towards white in twenty-two out of twenty-five birds from the south-west corner of the continent compared to only twelve out of twenty-six from Victoria (birds in American Museum of Natural History Collection), in each case the rest being of a richer, ochraceous colour. Over the bulk of the continent the more brightly coloured under-surface is dominant. The basis of this colouring requires study. Campbell (1901) created a south-western race (*westralasianus*) on the whitish ventral colouring and Mathews also comments upon the character. A separate race here is unjustified.

Wing-length measurements for adult males, taken during the spring and early summer, from various parts of the range are: Melbourne area (9), 91-98 mm (94); Sydney area (15), 90-98 mm (94); Brisbane-Bunya Mountains (5), 94-100 mm (95); Cairns (3), 93-95 mm (94); Normanton (4), 85-93 mm (90); Cape York (2), 86 and 91 mm; south-western Australia (7), 90-96 mm (93); Derby (4), 90-95 mm (93); Parry's Creek (4), 90-93 mm (92); coastal Northern Territory (2), 90 and 92 mm; Alexandra (1), 92 mm. There is some suggestion that breeding birds from the north of the continent are slightly smaller. The remarks of Keartland (1909) that the eggs of birds from the Fitzroy River are "much smaller" than those from the south should be noted.

Variation in *Halcyon sancta* is of a minor clinal type.

Several races have been described in Australia as follows: *ruficollaris* (Bankier) 1841 (Port Essington); *westralasianus* Campbell 1901 (south-western Australia); *confusus* Mathews 1912 (Cooktown); *ramsayi* Mathews 1912 (Parry's Creek). None of these is justified.

Halcyon chloris (Boddaert) 1783. (Mangrove Kingfisher.)

This kingfisher is strictly an inhabitant of the coastal mangroves and shoreline of the northern half of the continent. Its southern limit in the east is Brisbane and in the west, Carnarvon (Serventy and Whittell). The Australian form extends into New Guinea (Mayr 1941). *H. chloris* is a widespread species, being broken up into some forty races between Africa and the Pacific (Mayr 1945).

In Australia *H. chloris* is a migratory species. It arrives at Cape York from the north at the beginning of September (MacGillivray 1914) and reaches south Queensland at the end of that month (Miller 1936). The birds leave for the north in March but a few over-winter in the south. In the west of the continent Carter (1909) states that *H. chloris* is a common bird at Point Cloates from December until April. A bird was recorded in mid-June, however, and a pair on 1 September. The writer collected a bird at Port Keats (the only one seen) in August 1952.

Geographic variation: Museum material of this species is scanty. Moreover, there is much individual variation.

Specimens seen by the writer from Melville Island, Port Keats and Anson Bay, Cape York, Cooktown (the "type"), Cairns, Bowen, Aru Islands, and Daru, New Guinea, are of the same general type. Each bird in a pair from Point Cloates, near the southern extremity of range, and collected during the winter, has the green of the back much reduced and could best be described as brown above with a greenish tinge on the lower back, wings and rump. To what extent this drab colouring is due to age or seasonal factors cannot be stated. The remarks of Thomson (1935) to the effect that the plumage changes at the time of the moult from a dull sombre green to a vivid colour should be noted.

A pair of birds from Brisbane in the American Museum of Natural History Collection, and five unsexed birds in the Australian Museum, stand apart in having the top of the head green and the whole of the back, wings, and rump a bright blue-green. This contrasts with the dark brownish-green back and more drab blue-green wings and rump of birds from elsewhere. The Brisbane material was all collected in the mid-spring, however, and from no other locality is there an adequate series to compare with it.

Wing-length measurements for adult males of *H. chloris* from various parts of the species' Australian range are: Brisbane (4), 104-110 mm (106); Cairns (1), 110 mm; Cooktown (1), 107 mm; Cape York (3), 104-112 mm (109)—Thomson gives measurements of four November-December males as 105-119 mm (112); Groote Eylandt (2), 100 and 105 mm; Melville Island (3), 102-106 mm (104); Point Cloates (1), 97 mm; Aru Islands (2), 102 and 109 mm; Daru, New Guinea (2), 99 and 106 mm.

More material will be necessary before geographic variation in *H. chloris* in Australia can be understood. The race described from south Queensland (*colcloughi Mathews* 1916) may well prove to be justified. The forms *cooktowni* Mathews 1912 (Cooktown) and *melvillensis* Mathews 1912 (Melville Island), as the author subsequently admitted, are superfluous.

Tanysiptera sylvia sylvia (Gould) 1850. (White-tailed Kingfisher.)

The Australian form of this species is an inhabitant of the tropical rain-forests of the north-east corner from Cape York to Mount Spec, the southern limit also of its breeding range (J. O. Campbell, pers. com.). It winters in south-western New Guinea from the Setekwa to the Fly Rivers (Mayr 1941), arriving at Cape York from the end of October through November, departing again at April (Barnard 1909).

The Australian population of *T. sylvia* is a distinctive isolate (colour grounds). Wing-length measurements of typical adult birds are: Males (9) 95-102 mm (97); females (5) 93-97 mm (95).

VARIATION AND SPECIATION

Geographic forms in the Alcedinidae may be subdivided as follows:

(*a*) *Morphologically-differentiated isolates with the potential of developing into new species*:

Dacelo leachii cliftoni (Hamersley region of West Australia) and *D. leachii intermedia-superflua* (New Guinea); *Syma torotoro flavirostris* and *Tanysiptera sylvia sylvia* (isolated Cape York populations of New Guinea species); *Alcyone azurea pulchra* (Northern Territory—probable isolate); *Halcyon macleayi macleayi* (Northern Territory—probable isolate). There is also a fair measure of isolation between the Australian and New Guinea forms of *Alcyone azurea, Halcyon macleayi, Alcyone pusilla* (slight gene flow across Torres Strait?).

(*b*) *Former distinctive isolates as indicated by hybrid zones*:

Alcyone pusilla halli and *A. pusilla ramsayi* intergrade from Gulf of Carpentaria to Cape York and there is evidence of some southward gene flow from New Guinea (*A. pusilla pusilla*) into Cape York. In *Halcyon macleayi* there would appear to be limited gene flow into Cape York (*incincta*) from the New Guinea *elisabeth*.

(*c*) *Former isolate presumed to be connected to parental form by hybrid zone*:

Dacelo novaeguineae minor (Cape York).

(*d*) *Isolates that have not yet become differentiated*:

The Tasmanian population of *Alcyone azurea* comes into this category and possibly also the Mount Lofty population.

(*e*) *Clinal races* (*i.e., forms that, in the absence of isolation, are of no immediate evolutionary significance*):

(i) *South-north clines of decreasing size*: These occur in *Alcyone azurea, Alcyone pusilla, Dacelo leachii,* and possibly in *Halcyon macleayi*. There is a suggestion of one in *Halcyon sancta*. *Dacelo novaeguineae* has a small northern form but it is restricted to Cape York Peninsula. That is to say this species does not vary significantly in size over the bulk of its north-south range (some 1,400 miles) but it does over the last 200 miles. This indicates isolation, past or continuing.

An interesting question is whether or not south-north size trends continue across Torres Strait (distributional barrier) in those species that extend to New Guinea. It apparently varies with the species. In *A. azurea* and *A. pusilla* the New Guinea individuals would appear to be the same size as the Cape York ones. The New Guinea form of *Dacelo leachii,* however, appears to be larger than the adjacent mainland one, indicating that under isolation the trend has reversed.

(ii) *Colour clines*: These are best seen in *Dacelo leachii*. Populations have darker backs where rainfall is highest; that is, the variation apparently has a climatic basis.

(*f*) *Species in which there is no or negligible geographic variation*:

Halcyon pyrrhopygia, the only true interior species, does not vary. Continuity of range and the fact that the nomadism increases the chances of individuals from different parts of the continent mating, are relevant factors here.

Halcyon sancta would appear to have a limited amount of clinal variation, but certainly not sufficient to warrant recognition. The species is apparently a recent immigrant to Australia (Mayr). It undertakes a certain amount of south-north migration.

DISTRIBUTIONAL BARRIERS IN THE KINGFISHERS

These are as follows:

Water Barriers.

(i) Torres Strait (width about 100 miles, but with intervening islands; see Fig. 1). This isolates distinctive forms in several species.

(ii) Bass Strait (width about 120 miles, with some intervening islands). This barrier stops the southward spread of *Dacelo novaeguineae.* The Tasmanian stock of *Alcyone azurea,* isolated to the south of it, has not differentiated. Bass Strait is not of great importance in the kingfishers since they are essentially a tropical group.

(iii) Sea barrier between Melville Island and the adjacent mainland (width perhaps only 10 miles). This could have assisted in the development of the dark Melville population of *Dacelo leachii.* (See Fig. 1.)

Land Barriers (inhospitable terrain).

(i) Tongue of Great Sandy Desert that extends to the sea at Ninety-Mile Beach, north-western Australia. The distinctive race of *Dacelo leachii (cliftoni)* has developed to the south of this (see Fig. 1). The presence of odd "intermediate" birds on the Fitzroy River suggests there may be some crossing of the barrier from the south today.

(ii) Dry country at head of Gulf of Carpentaria. This isolates (or formerly isolated) the distinctive north-western forms of *Alcyone azurea, Halcyon macleayi,* and *A. pusilla.*

(iii) Nullabor Plain is a barrier to the westward spread of the Kookaburra, *Dacelo novaeguineae. Alcyone azurea* reaches no further west than Spencer Gulf. Spread of the latter may be prevented by absence of streams but why *D. novaeguineae* is absent from the south-west is a major distributional mystery for the majority of eastern forest forms are also in the south-west. Obviously it was an occupant of the south of the continent at the time when good country extended across the head of the Great Australian Bite and forest birds occurred from east to west. Now that it has been artificially introduced to the south-western forests *D. novaeguineae* is thriving there.

NOMENCLATURE

The following geographic forms should be recognised in the Australian Alcedinidae:

Alcyone azurea azurea Latham 1801. Synonyms: *diemenensis* and *victoria.* South Australia to Tasmania and New South Wales, grading into

A. azurea mixta Mathews 1912. Eastern and northern Queensland.

A. azurea pulchra Gould 1846. Synonym: *alisteri.* Coastal Northern Territory and the Kimberleys.

Alcyone pusilla halli Mathews 1912. Synonym: *yorki.* Hinchinbrook Island to Cairns, merging via the Cape York and Gulf of Carpentaria populations into

A. pusilla ramsayi North 1912. North-western Australia.

Syma torotoro flavirostris Gould 1850. Northern Cape York.

Dacelo novaeguineae novaeguineae Hermann 1873. Synonym: *tregellasi.* Southern Australia north to Cairns.

D. novaeguineae minor Robinson 1900. Synonyms: *mclennani* and *watsoni.* Cooktown to Cape York.

Dacelo leachii leachii Vigors and Horsfield 1827. Synonyms: *macarthuri, occidentalis* and *mungi.* South Queensland, across the inland to the Gulf of Carpentaria, Northern Territory, and Kimberleys.

D. leachii kempi Mathews 1912. Cape York.

D. leachii cervina Gould 1838. Synonym: *nana.* Melville Island and adjacent coast of Northern Territory.

D. leachii cliftoni Mathews 1912. De Grey River to Shark Bay, Western Australia.

Halcyon pyrrhopygia Gould 1840. Synonyms: *obscurus, utingi.* Australia generally, drier regions.

Halcyon macleayi macleayi Jardine and Selby 1830. Synonyms: *distinguendus, publa, caeruleus.* North-western Australia.

H. macleayi incincta Gould 1838. Synonym: *barnardi*. Central coastal New South Wales to Cairns, and to Cape York(?).

Halcyon sancta sancta Vigors and Horsfield 1827. Synonyms: *ruficollaris, ramsayi, westralasianus, confusus*. Australia generally.

Halcyon chloris sordida Gould 1842. Synonyms: *cooktowni and melvillensis*. Northern shoreline of Australia from Carnarvon in the west to eastern Queensland. Future work may show that the populations of south Queensland belong to a separate race.

H. chloris colcloughi (Mathews) 1916.

Tanysiptera sylvia sylvia Gould 1850. Synonym: *dydimus*. Cape York to Mount Spec.

SUMMARY

A taxonomic study of the Australian kingfishers reveals that out of ten species four do not vary geographically within the continent. Two of these, however, are New Guinea species with a mere toehold in the north-east. Of the other species *Dacelo leachii* is divisible into four races within Australia, whilst *Dacelo novaeguineae*, *Alcyone azurea*, *A. pusilla*, and *Halcyon macleayi*, have two each.

Isolates (forms with the potential of developing into new species) are few. Five species each have a distinctive form that must have arisen in isolation. In three of these (*Dacelo leachii cliftoni, Alcyone azurea pulchra, Halcyon macleayi macleayi*) isolation would appear to be still virtually complete. In *Alcyone pusilla*, however, distinctive north-eastern and north-western populations are now connected with each other, or with New Guinea populations, by a hybrid zone. The small Cape York form of *Dacelo novaeguineae* (*minor*) is presumably also now connected with the main stock by a hybrid zone.

Three isolates in ten species means that there is less than one form with the potential of developing into a new species to every three species in the Australian kingfishers. This is a relatively low figure and shows that isolation within Australia is of much less importance than between the continent and New Guinea.

Acknowledgments

I should like to express my thanks to the authorities of those museums which made material available to me, and especially to Harvard University and the American Museum of Natural History, whose financial grants made it possible for me to study the magnificent collections of Australian birds in New York.

References

Austin, T. P. 1909. See North 4: 360.

Barnard, H. G. 1909. See North 4: 379.

Bennett, K. H. 1909. See North 4: 370.

Campbell, A. J. 1901. Stray feathers. *Emu* 1: 25.

Campbell, A. J. and White, S. A. 1910. Birds identified on the Capricorn Group during expedition of R.A.O.U., 8th to 17th October, 1910. *Emu* 10: 197.

Carter, T. 1909. See North 4: 376.

Dove, H. S. 1918. See Mathews 7: 187.

Gilbert, P. A. 1935. The seasonal movements and migrations of birds in eastern New South Wales. *Emu* 35: 20.

Jarman, H. 1944. The Birds on Banka Banka Station, Northern Territory of Australia. *S. Austr. Orn.* 17: 24.

Keartland, G. A. 1909. See North 4: 373.

Lysaght, A. 1956. Why did Sonnerat record the kookaburra *Dacelo gigas* (Boddaert) from New Guinea? *Emu* 56: 224.

MacGillivray, W. 1914. Notes on some North Queensland birds. *Emu* 13: 160.

———, 1918. See Mathews 7: 109.

Mack, G. 1953. Birds from Cape York Peninsula. *Mem. Qld. Mus.* 13: 16.

Mathews, G. M. 1918. *The Birds of Australia*. H. F. & G. Witherby, London, 7: 90.

Mayr, E. 1937. Notes on New Guinea birds II. *Am. Mus. Novit.* No. 939.

———, 1941. *List of New Guinea birds*. Am. Mus. Nat. Hist., New York: 89.

———, 1944. Timor and the colonization of Australia by birds. *Emu* 44: 113.

———, 1945. *Birds of the Southwest Pacific*. Macmillan, New York: 80.

Miller, R. S. 1936. The Mangrove Kingfisher. *Emu* 36: 152.

North, A. J. 1909. *Nests and Eggs of Birds Found Breeding in Australia and Tasmania*. Australian Museum, Sydney. 4: 360 on.

Serventy, D. L. and Whittell, H. M. 1951. *Birds of Western Australia*. Patersons Press, Perth: 244.

Sharland, M. S. R. 1945. *Tasmanian Birds and How to Identify Them*. Oldham, Bedome, and Meredith, Hobart: 75.

Thomson, D. F. 1935. *Birds of Cape York Peninsula*. Gov. Printer, Melbourne: 47.

Thorpe, J. A. 1909. See North 4: 357.

Sydney: A. H. Pettifer, Government Printer—1957.

VARIATION AND SPECIATION IN THE AUSTRALIAN FLYCATCHERS

(*Aves: Muscicapinae*)

By Allen Keast

(Figures 1–7)

(Manuscript received 7.6.57.)

SUMMARY

The Australian Muscicapinae, comprising some thirty-four species, is currently divided into seventeen genera. A study of generic characters shows that of these *Carterornis* is a synonym of *Monarcha, Amaurodryas* and *Melanodryas* of *Petroica,* and *Quoyornis* of *Eopsaltria.* The writer follows Mayr (1941b) in separating *Tregellasia* from *Eopsaltria.* Mathews' generic name *Peneoenanthe* is reintroduced for the Mangrove Robin. The writer has been conservative in making generic changes, the view being taken that it is better to retain 'small' genera where relationships are doubtful than, for the sake of reducing the number of genera, to risk linking them with groups to which they may not belong.

A detailed study of infraspecific variation has been made. Nineteen of the species vary geographically within the Australian continent. Most of those that do not are New Guinea or tropical species that have only a 'toehold' in Australia. Distributions and habitats are detailed. The relatively large collections available to the author have permitted a detailed reassessment of named races and about sixty (slightly more than half those currently recognised) are reduced to synonymy.

Speciation is actively occurring in many flycatchers and isolates, forms with the 'potential' of developing into new species, are numerous. Of the fifteen well-differentiated isolates one (*Petroica rodinogaster*) has recently reached species status (as shown by resumption of contact with parental form without interbreeding. Two, the distinctive subspecies *Poecilodryas superciliosa cerviniventris* and *Eopsaltria australis griseogularis* though isolated are approaching that stage of morphological differentiation typical of species. In addition to the isolates referred to above most of the New Guinea species with a 'toehold' in northern Australia have started to differentiate here. The all-important isolating barriers in the flycatchers are extensive gaps in the particular habitat (tracts of arid country and sea).

Clinal variation (gradual change in a character without isolation) is pronounced in several flycatchers. It falls, in the main, into (*a*) tonal differences associated with rainfall (Gloger Effect), and (*b*) size differences according to latitude (Bergmann Effect). A most interesting demonstration of the effects of isolation on the tendency for northern populations of widely-ranging birds to be smaller, is noted in *Seisura inquieta.* Here the isolated northern populations are some 20 per cent. less than the most southern ones compared to the 'average' figure of 11 per cent. for *Rhipidura leucophrys,* in which the variation is in the form of a continuous cline.

INTRODUCTION

The present paper deals with infraspecific variation and speciation in those birds comprising the Family Muscicapidae of the 1926 *Checklist* of the Royal Australasian Ornithologists' Union, which group is regarded as a sub-family in the recent list of Mayr and Amadon (1951). The following genera are currently recognised: *Rhipidura* Vigors and Horsfield (four species), *Seisura* Vigors and Horsfield (one), *Piezorhynchus* Gould (one), *Myiagra* Vigors and Horsfield (three), *Machaerirhynchus* Gould (one), *Arses* Lesson (two), *Monarcha* Vigors and Horsfield (three), *Carterornis* Mathews (one), *Microeca* Gould (four), *Petroica* Swainson (five), *Melanodryas* Gould (one), *Amaurodryas* Gould (one), *Eopsaltria* Gould (one), *Quoyornis* Gould (two), *Heteromyias* Sharpe (one), *Poecilodryas* Gould (one), *Tregellasia* Mathews (two).

Genera and generic limits are assessed and some changes recommended.

Materials and Methods

The work is based on specimens in the American Museum of Natural History, New York, and the Australian Museum, Sydney. In the case of *Seisura inquieta* (Latham), *Monarcha melanopsis* (Vieillot), *Rhipidura fuliginosa* (Sparrman), and *R. leucophrys* (Latham) material in the National Museum of Victoria, Melbourne, was also used, and with *S. inquieta, R. leucophrys,* and *R. rufiventris* (Vieillot), that in the Western Australian Museum, Perth. Specimens in Melbourne, Adelaide and Brisbane, were seen in the case of *Eopsaltria australis* (White), in addition to those recently collected in the Carnarvon Ranges by Dr. K. Stager and now in the Los Angeles County Museum.

Standard taxonomic methods have been used and measurements made as follows: Wing-length, from angle of wing to tip, straightened along the rule; tail-length, from between base of centralmost two feathers to the tip; bill-length, from end of feathers to tip. Wing-length has been taken as the criterion of over-all size (Amadon 1943). In discussions of wing formula the feathers were numbered from the outermost inwards.

Isolate, as used in discussing geographic variation and speciation, means a population separated from the main stocks by some distributional barrier. This is the first step in the speciation process. In the present work attention is concentrated on isolates that have become differentiated morphologically. By clinal variation is meant the gradual and continuous change in a particular character from one part of the geographic range to another. Variation of this type, whilst it may be marked, is of no immediate significance from the viewpoint of speciation in that no isolation is involved.

GENERA AND GENERIC LIMITS

The thirty-four species are placed in fifteen genera in the *Checklist* of the R.A.O.U. and in twenty-nine by Mathews in his 1946 *Working List.* The checklist, which is the work of a committee, represents a somewhat middle course. More recently the subjugation of one or another of the genera has been advocated. Thus Condon (1951) included *Melanodryas* under *Petroica;* Mack (1953) has restored *Carterornis* to *Monarcha,* a position it formerly occupied; Serventy and Whittell (1948) have placed *Quoyornis* (grey robins) in the same genus as the yellow robins, *Eopsaltria,* while Mayr (1941), in his *Checklist of the Birds of New Guinea,* has placed *Piezorhynchus* under *Monarcha.*

The Australian flycatcher fauna is a composite of endemic Australian species without obvious relatives; species whose affinities lie with the Pacific forms and recent immigrants conspecific with New Guinea birds. There is a large number of diverging and evolving lines occupying a variety of ecological niches. The task of assessing relationships and generic limits is complicated by the fact that the Pacific flycatchers are in need of generic revision (Mayr and Amadon 1945).

The Australian Muscicapinae can be separated into the following subdivisions:

(*a*) *Rhipidura*: The members of this genus have rounded wings, long tails that may be carried as fans, prominent rictal bristles, small bills, and weak feet. They feed by sallying forth after flying insects, can hover, twist, and turn rapidly, and have melodious, chattering call-notes. The nests, which are cup-shaped structures placed on a horizonal branch, have cobwebs, fine strands of bark and grass, as the basic material. The eggs of the various species form a closely-matching group. In terms of colour and colour-pattern the four Australian species fall into two groups; *fuliginosa-rufifrons* (Latham)-*rufiventris,* and *leucophrys.* The last-named is a conspicuous black and white species (compared to the grey and rufous colouring of the others), has a long bill, large feet, wing less rounded, lacks the white tip to the tail, and is an inhabitant of dry, more open, country. The tail: wing ratio of the various species is as follows: *R. fuliginosa,* 1.17-1.27; *R. rufifrons,* 1.12-1.24, *R. rufiventris,* 0.88-0.93; *R. leucophrys,* 0.96-1.04. The genus *Rhipidura* extends well beyond Australia but, at least as far as the continent is concerned, forms a neat, self-contained group.

(*b*) *Myiagra, Seisura,* and *Piezorhynchus* represent another self-contained group. *Myiagra* spp. have broad, flat and unkeeled bills, long and square tails, prominent rictal bristles, and long rounded wings. In field habits they stand apart from other flycatchers. The long tail is constantly twitched or oscillated. The birds live in open situations, darting from the branches after flying insects, but also getting them amongst the branches and leaves. The calls are harsh and strident. The nest is characteristic, being cup-shaped and built on an exposed branch typically camouflaged with lichen.

Seisura inquieta differs from *Myiagra* spp. in having a long, narrow bill, and in the sexes being fairly similar. They have, however, the same sort of tail movements, method of catching insects in the air, aggressive behaviour whilst breeding, and closely similar call, nest and eggs. *Seisura inquieta* has developed a novel form of behaviour in obtaining its insect food, that of hovering above the grass and uttering a continuous succession of chattering notes reminiscent of an egg-mixer. Whilst so doing the bird looks vertically downward in the manner of a foraging gull.

The tail of *Seisura inquieta* is somewhat rounded and the wing is distinctly more rounded than in Australian *Myiagra* spp. In *M. cyanoleuca* (Vieillot) and *M. rubecula* (Latham) (both migratory species) the 4th primary is greater than (or equal to) the 5th, which generally exceeds the 3rd, while the 6th is the next longest. In *Seisura,* by contrast, the 5th primary is the longest, the 6th and 4th subequal, and the 3rd and 7th next longest. The tail : wing ratios of the two genera are much the same: *Myiagra cyanoleuca,* 0.85-0.90; *M. rubecula,* 0.80-0.90; *Seisura inquieta,* 0.87-0.90.

There does not appear to be any doubt that the affinities of *Piezorhynchus alecto* (Temminck and Laugier) lie with this group and not with the Monarch flycatchers, where it has been placed (R.A.O.U. *Checklist;* Mayr 1941). It has the same sheeny-black feathering dorsally, similar male and female forms, and same colour range, as *Myiagra* spp. Its bill, though keeled, is not unlike that of *Seisura inquieta* and there are similar rictal bristles. The tail : wing ratio in males is 0.82-0.90. The wing is of the rounded type, as in the equally sedentary *Seisura inquieta.* The wing formula is somewhat different, p. 7 exceeding p. 3 (it is typically the reverse in *Seisura*) and p. 9 exceeding p. 2 (it occasionally does so in *Seisura*). In behaviour there is a definite link. Mr. N. Chaffer, who recently spent some days photographing *Piezorhynchus alecto* in northern Queensland, informed me that the bird has the same habit of erecting the head feathers in the form of a semi-crest as has *Seisura inquieta.* It also swings the tail from side to side. The nest is of the same general type. Study of egg collections reveals that the *Piezorhynchus alecto* egg is spotted with grey and brown, as in *Myiagra* spp. and *Seisura inquieta,* not with pink or red as in *Monarcha* spp.

Piezorhynchus alecto differs somewhat in feeding habits from typical *Myiagra* spp. in that it feeds close to the ground, fluttering amongst the tangled masses of roots in sago swamps, mangroves, and creekside vegetation, to snap up insects disturbed by its movements. The feeding habits of *Seisura inquieta,* however, bridge the gap.

Whether or not species in the genera *Myiagra, Seisura,* and *Piezorhynchus,* should be regarded as belonging to a single genus depends largely on whether a worker wishes to give his genera a wide or a 'moderate' meaning. The segregation is an old one since *Seisura inquieta* obviously developed in Australia under open-country conditions, as did *Rhipidura leucophrys. Piezorhynchus alecto,* which is quite a specialized form, presumably originated in the tropics.

(*c*) *Machaerirhynchus.* This genus is distinctive on account of its enormously broadened and flattened bill.

(*d*) The Monarch flycatchers (*Monarcha, Carterornis*).

Mayr, in his New Guinea checklist (1941a) has accepted a somewhat wide meaning for the genus *Monarcha,* including within it the chestnut-breasted group (*M. melanopsis* and its allies), the golden flycatcher (*M. chrysomela* (Garnot) 1829), shining flycatcher (*M. alecto* (Temminck et Laugier) 1827), pied flycatcher (*M. guttula* (Garnot) 1829), as well as the aberrant long-tailed *M. axillaris* Salvadori 1875. Of these, the chestnut-breasted group, a pied flycatcher (not necessarily closely related to the pied birds of New Guinea), and the shining flycatcher (= *Piezorhynchus alecto*) occur in Australia and need to be discussed here.

Monarcha melanopsis, the type species, is a somewhat heavy-billed flycatcher that obtains its insect food from the branches and leaves. The bill is unflattened, the tail square, and legs and feet are fairly strong. In coloration it is chestnut, grey and black. It lives in rain forest, has loud, melodious call-notes, and constructs a cup-shaped nest in which green moss is the dominant material. *M. trivirgata* (Temminck) is smaller, with different markings, but has the general build, colours, and habits.

The small, pied, *Carterornis leucopsis* (Gould) has similar bill, legs, and feet to *M. melanopsis* and *M. trivirgata.* Its wing formula approaches that of *M. trivirgata,* primaries 4 and 5 being longest and equal and usually longer than 3 which equals 6 (sometimes 3, 4, 5, 6 are subequal in *C. leucopsis*). Thereafter p.7 exceeds p.8 which exceeds p.2.

In *M. melanopsis*, by contrast, 4 and 5 are longest, or sometimes 3, 4, 5, which exceed 6, followed by 7, 2 and 8. The tail:wing ratio for *M. melanopsis* is 0.77-0.81, for *M. trivirgata* 0.87-0.92, and for *C. leucopsis*, 0.89-0.91.

Carterornis leucopsis is a rare bird and few accounts of its behaviour are available. Favaloro (1930), however, has drawn attention to its similarity with *M. trivirgata* both in feeding habits and nesting behaviour. Photographs show that the nests of the two do not differ appreciably and, judging from descriptions, the eggs are similar.

Basically, *Carterornis leucopsis* approximates to flycatchers of the *melanopsis-trivirgata* type, differing mainly in coloration, colour-pattern, and in the protuberant gorget or throat tuft (Favaloro 1930). These differences are however, hardly sufficient to warrant generic differentiation and I agree with Mack (1953) and others that the generic name *Carterornis* is unnecessary.

The Shining Flycatcher, *Piezorhynchus alecto*, placed with the Monarch flycatchers by various workers, is fairly distinctive. It differs in colouring, colour-pattern, and in having marked sexual dimorphism, from species typical of the genus *Monarcha*. The immature male is brown and the tail is rounded and not square. The wing has a beautifully rounded contour, seen also in that of the sedentary *M. trivirgata*. The wing of *Piezorhynchus alecto*, however, is characterised by a short p.2, exceeded by p.9 and frequently some of the outer secondaries. In the majority of specimens p.7 exceeds p.3. The roundness of the wing, accordingly, is due to a relatively short second and third primary. In *M. trivirgata*, as already mentioned, p.3 exceeds p.7 and p.2, with rare exceptions, exceeds p.9.

There is little in common in behaviour between *Piezorhynchus alecto* and Australian representatives of the genus *Monarcha*. The habit of swinging the tail from side to side is lacking in the latter, as is also that of erecting the head feathers. The nest and eggs are also different.

(*e*) *Arses*. This small genus of black and white birds (with brown females in New Guinea) comprises species which are undoubtedly closely related to the Monarch flycatchers but are generically distinct. The bill is like that of *Monarcha* spp. The wing is long and rounded (p.4 and p.5, or occasionally 4, 5, 6, are longest, followed by 3, then 7, then 8 and 2). The tail is fairly square and is long (tail:wing ratio, 0.85-0.94). The distinctive features of the genus are colour-pattern, long neck feathers that are frequently elevated to form a frill, and blue fleshy eye-rim. One Australian species (*A. kaupi* Gould) has an unusually long hind toe, apparently associated with its habit of moving over the trunks and branches in search of food in the manner of a tree-creeper. This species is also said to spread its tail when fluttering about the branches (North 1903).

The habits and song of *Arses* spp. are somewhat different from those of the Monarch flycatchers. The nest is distinctive, resembling a miniature basket and frequently placed on a hanging vine. The eggs are fairly distinctive.

(*f*) *Microeca*. I agree with Mayr (1941b) and Vaurie (1953) in recognising this as a well-defined small genus which stands apart on morphological grounds (broad bill, pronounced rictal bristles, long wing, weak tarsus), and in behaviour, habits, nest and eggs. Its method of hunting is to sit on an exposed branch and sally forth after passing insects. It is thus an aerial feeder and this is reflected in its morphological characteristics.

(*g*) The Australian Robin-like Birds (*Petroica, Melanodryas, Amaurodryas, Quoyornis, Heteromyias, Poecilodryas, Eopsaltria, Tregellasia*): In this group are comprised somewhat generalized flycatchers that take their food from the branches or ground and are typically robin-like. Their appearance reflects the general similarity in habits and they differ in little more than colour and colour-pattern. The sixteen species are currently broken up into eight or more genera. In terms of dominant colour these are: *Petroica* spp., males with much red (replaced by black in New Guinea and New Zealand species), females brown; *Melanodryas cucullata* (Latham), pied male and brown female; *Amaurodryas vittata* (Quoy and Gaymard), brown, sexes alike; *Quoyornis* spp., grey, sexes alike; *Eopsaltria australis* (White) and *Tregellasia* spp. (the latter the large-headed robins), yellow-breasted and sexes alike; *Heteromyias cinereifrons* (Ramsay) and *Poecilodryas superciliosa* (Gould), somewhat complicated colour-pattern involving brown, greys, black and white, with the sexes alike.

In their morphological characters these genera compare as follows:

Bill: This is of a generalized type in most species. It is, however, long in *Quoyornis leucurus* (Gould), relatively small in *Petroica* spp., broad and shallow in *Tregellasia* spp., wide in *Poecilodryas superciliosa*, and large, high and narrow in *Heteromyias cinereifrons*.

Rictal Bristles: These are prominent in species in the genus *Tregellasia*, and in *Poecilodryas superciliosa* and *Quoyornis leucurus*, but small in species in other genera.

Tail Shape: The tail is square in all species with the exception of *Quoyornis leucurus*, in which it is rounded.

Legs: These are relatively strong in the whole group though, as would be expected, somewhat weaker in those species of *Petroica* that are arboreal. Scutellation varies somewhat between species but as it is influenced by age I do not consider it a reliable generic character. In *Heteromyias cinereifrons*, however, scutes are virtually absent and the legs are smooth.

Wings: Primaries 4 and 5 are invariably the longest in the Australian robins. Individuals with nos. 3, 4, 5 subequal (and 3 exceeds 6) frequently occur in *Eopsaltria australis*, *Amaurodryas vittata*, and *Melanodryas cucullata*. Primary 6 typically exceeds p.3 in *Eopsaltria australis*, *Quoyornis leucurus*, and *Q. georgianus* (Quoy and Gaimard), *Tregellasia* spp., *Poecilodryas superciliosa*, *Heteromyias cinereifrons*, but commonly equals it in *Petroica* spp., which inclines more to the previous type. Primary 2 typically exceeds p.7 in *Melanodryas cucullata* and generally in *Petroica* spp. In *Amaurodryas vittata* p. 7 mostly exceeds p. 2, but they may be of the same length. In all the other genera p.7 exceeds p.2.

It is difficult to say what importance should be given to wing formula in assessing generic limits. If one were to claim it as positive evidence of close relationship in the case of *Melanodryas cucullata* and *Petroica* spp. the same could be said for *Quoyornis* spp., *Tregellasia* spp., and *Poecilodryas superciliosa*, although these genera are quite dissimilar in other features.

Tail:wing ratios for various robins range as follows: *Eopsaltria australis*, 0.72-0.77; *Quoyornis georgianus*, 0.78-0.83; *Quoyornis leucurus*, 0.76-0.78; *Amaurodryas vittata*, 0.69-0.74; *Melanodryas cucullata*, 0.67-0.72; *Petroica phoenicia* Gould, 0.68-0.71; *Petroica rosea* Gould, 0.77-0.81; *Tregellasia capito* (Gould), 0.67-0.69; *Poecilodryas superciliosa*, 0.76-0.78; *Heteromyias cinereifrons*, 0.65-0.67; with New Guinea *H. albispecularis* (Salvadori) about 0.63. These ratios indicate that *Heteromyias cinereifrons* and *Tregellasia* spp. have relatively short tails, whereas the tail is relatively long in *Quoyornis* spp., *Poecilodryas superciliosa* and *Petroica rosea*.

It would appear that tail:wing ratios can be of little assistance in assessing robin relationships.

Distinctive Colour Markings: A wing-bar occurs in most species and is typically prominent. It is, however, faint in *Eopsaltria australis* and *Tregellasia* spp. In *Quoyornis leucurus* alone it is absent. There is a distinctive white band at the base of the tail in only two species, *Quoyornis leucurus* and *Melanodryas cucullata*. It is faintly visible in *Amaurodryas vittata*.

Egg Colouring: The eggs of Australian robins are of three types:

(*a*) Blue or greenish-blue eggs spotted with reddish-brown (*Eopsaltria australis*, *Tregellasia* spp., *Poecilodryas superciliosa*, *Quoyornis georgianus*).

(*b*) Brownish-blue or greenish-blue eggs without spotting (*Melanodryas cucullata*, *Amaurodryas vittata*, *Quoyornis leucurus*).

(*c*) Ground-colouring of egg grey to white, spotting grey or greyish-brown not red (*Petroica* spp.). The eggs of most species are readily distinguishable. *P. goodenovii* differs in having a bluish ground-colour thus, in a measure, connecting this group with (*a*). The egg of the large *Heteromyias cinereifrons* has a grey to buff ground-colour and brownish markings. Whilst this egg can be grouped under category (*c*) it stands somewhat apart.

Egg-colouring could be said to confirm that *Amaurodryas vittata* is closely-related to *Melanodryas cucullata* and *Quoyornis georgianus* to *Eopsaltria australis*. Interestingly enough it does not support the presumed close relationship of *Melanodryas cucullata* to the genus *Petroica*.

Nest Structure: All species have a generalized cup-shaped nest on a branch. Strips of bark and lichen serve as camouflage. Those of the various genera are recognizable on materials used and size. It is doubtful, however, if fundamental differences are involved so much as: (*a*) availability of the different materials and (*b*) a compromise between the conflicting needs of a small nest that is difficult to see and a bulky one that is warm. In the latter respect it might be noted that *Petroica goodenovii*, living in the interior where cover is sparse, has a small nest, and *P. rodinogaster* of the cold, dense, Tasmanian forests,

a large and bulky one. The nest of the mangrove dweller *Quoyornis leucurus* is a small version of the generalized *Eopsaltria-Melanodryas* type. That of the large *Heteromyias cinereifrons,* however, is a loose structure of roots, leaf skeletons, fibre and moss, and bears little resemblance to the nest of any of the other robins.

The Nestling Bird: A complete series of nestlings is not available for study. A brown, mottled immature is the rule in robins (Mathews 1921-22). New collections will have to be made, however, before juvenile colouring can be properly assessed as a generic character.

General Behaviour: Robins, with few exceptions, feed both in the branches and on the ground. Movements, except when attacking prey, tend to be slow and sedate. All escape observation by remaining still. The call tends to take the form of a piping succession of notes but some species (*e.g.,* a few members of the genus *Petroica*) are relatively silent. Some genera share odd characteristics of behaviour (which may not indicate close relationship). Thus *Eopsaltria australis, Tregellasia* spp., and *Heteromyias cinereifrons,* have the habit of clinging vertically to tree-trunks. and from that position surveying the surroundings. A vertical flicking of the tail is to be seen in *Eopsaltria australis* and *Petroica* spp.

Generic Relationships—Summary: The Australian robin-like birds fall into a number of divisions in terms of colour and colour-pattern and, on the basis of these, genera have been created. When, however, an attempt is made to confirm the genera by morphological criteria and in terms of behaviour it is found that the differences are less clear-cut. Nor does it seem possible, save at the risk of combining elements that are not closely related, to substantially reduce the number of genera.

The position may be rationalized to some extent as follows:

(1) *Quoyornis* Gould. This genus, as at present used, is composed of two essentially unrelated species. One of them, *Q. georgianus* really belongs to *Eopsaltria.* The other, the mangrove robin, *Q. leucurus,* is so distinct that it should be placed in a monotypic genus (*Peneoenanthe* Mathews).

The evidence for placing *Quoyornis georgianus* under the genus *Eopsaltria* rather than associating it with *Melanodryas* is as follows: (*a*) There is no transverse bar at the base of the tail; (*b*) wing formula; (*c*) eggs; (*d*) behaviour, *vide* the following remarks of Serventy and Whittell (1948):

> In general habits the species is very similar to the Western Yellow Robin and has the same mannerisms of clinging to the side of a tree and remaining motionless, and of jerking its tail and wings.

Accordingly, I follow Serventy and Whittell in placing this species in the genus *Eopsaltria.*

Quoyornis leucurus (R.A.O.U. *Checklist*) (*Poecilodryas pulverulenta* (of Mayr 1941)).[1] The Mangrove Robin of the north has only a superficial colour resemblance to the grey robin of the south-west, despite its having been placed with it by many workers. In fact, its characteristics of a long, strong, bill and prominent rictal bristles, rounded tail, and absence of wing-bar, are such that it is surprising its distinctiveness from *Quoyornis* has not been more widely stressed.

Mayr (1941b) placed it in the genus *Poecilodryas,* but only with certain misgivings, writing: "We now come to three species which might be included in *Poecilodryas,* partly because their plumages are not completely known and partly to avoid putting them in monotypic genera". He then proceeds to comment on the unusual "*Pachycephala*-like compressed" bill (there would appear to be a typographical error here for the bill is referred to as "small" and the rictal bristles as "weakly-developed" whereas, compared to typical robins, the reverse is the case.)

The Mangrove Robin is without close relatives and is as distinct from *Poecilodryas superciliosa* and *Eopsaltria georgiana* as any of the other robin genera are from each other. There is no alternative, from the viewpoint of consistency, but to place it in a monotypic genus (it will take the name *Peneoenanthe* Mathews 1920).

---

[1] Iredale (1956) has rejected the specific name *pulverulenta* and uses the name *leucurus* Gould 1869. Admittedly the description by Bonaparte (1850) of the bird collected and labelled by Muller is a poor one: "*Myiolestes pulverulentus.* Grisea: subtus alba." The name, however, has clear priority and should stand.

(2) *Amaurodryas* and *Melanodryas*. The former is but a "henny-plumaged" insular derivative of *Melanodryas cucullata*. Its relationship here, rather than to the genus *Eopsaltria*, is seen from: (*a*) There is a trace of a transverse bar at the base of the tail; (*b*) egg colouring; (*c*) general behaviour. Field observers liken it to *Melanodryas* on general appearance and nest, the fact that clinging vertically to trunks is not a basic habit, and because it has not the piping call-note of *Eopsaltria*.

The preceding survey has indicated a close similarity of *Melanodryas cucullata* to members of the genus *Petroica*. Condon (1951) has already advocated that it should be placed under this genus. The ways in which *M. cucullata* resembles a typical *Petroica* such as *P. multicolor* are as follows: (*a*) The colour patterns are remarkably similar, even to the extent of distribution of white on the wings; (*b*) in both groups the females are brown; (*c*) the wing formula is similar, especially in primary 2 typically exceeding p.7; (*d*) taking size differences into account bills, legs and feet, are similar, as are the rictal bristles; (*e*) the two have certain similarities in habits, notably that of perching on a stump or post in clearings and fields and from there flying down to take food on the ground. The two differ in (*a*) general size; (*b*) egg colour and patterning; (*c*) the fact that red is absent in the male of *Melanodryas*. New Guinea and New Zealand members of the genus *Petroica*, however, are black and white, lacking red, so that this objection is removed. Hence it would appear that, subject to a comparison of nestlings at a future date, the only real differences between *Melanodryas* and *Petroica* lie in the eggs and in general size. Hence the former name should be reduced to synonymy.

(3) Genus *Tregellasia*. Mayr (1941) has restored this genus of Mathews and I agree with his action. These birds (*T. capito* and *T. leucops*) have conspicuously large heads, flattened bills, and prominent rictal bristles. Their relationship to the genus *Eopsaltria*, with which they share similar colouring, eggs, wing formulae, and the habit of clinging to the vertical sides of trees is, accordingly, not particularly close. They should be separated generically.

INFRASPECIFIC VARIATION

Rhipidura fuliginosa (Sparrman) 1787. (Grey Fantail)

(Figure 1.)

This species extends widely through the sclerophyll forests, rain forests, savannah, and mangroves of the periphery of the continent. There is an isolated stock in the mountains of central Australia. *R. fuliginosa* requires scrubby thickets, leaving the more open places to *R. leucophrys*. This applies even in the forests of the south-east and south-west, where it reaches it greatest concentrations.

The species is absent from great areas of the inland. For example, on a traverse of the continent during the winter of 1952 from Port Augusta to the Macdonnells and thence to Wyndham, Port Keats, the Barkley Tableland, Mount Isa, and Cairns, the writer saw the species only at Port Augusta, Port Keats (in mangroves), Normanton (monsoon forest), and Cairns. The evidence suggests that it is a very rare bird in the desert centre of the continent (in addition to North's specimens from Stoke's Pass in the Macdonnells there are records from Marree, Lake Frome, and Cooper's Creek (Terrill and Rix 1950). The species is apparently 'thinly spread' and much broken up distributionally in the north-west (*e.g.*, Kimberleys) where it occurs only in mangrove thickets.

Rhipidura fuliginosa is sedentary, though some local movements occur (Lamm and Calaby 1950; Serventy and Whittell 1948).

Specimens: Tasmania (series); King Island (1); Flinders Island (2); Melbourne, Sydney, Adelaide (all series); Kangaroo Island (3); Richmond River (1); Bunya Mountains (2); Rockhampton area (1); Burnett River (1); Cairns (series); Utingu, on Cape York (series); Normanton (4); Burketown (1); Leichhardt River (2); Alexandria, N.T. (1); Melville Island (series); Point Torment and Derby (series); Carnarvon and Boolathanna (series); Point Cloates (3); south-western Australia (series); Stoke's Pass in central Australia (2); Hall Sound, New Guinea (3).

Geographic Variation: *R. fuliginosa* is a highly plastic species. Whilst most populations are variable the following geographic colour types occur, distributed as in Figure 1.

(1) Tasmania and the Bass Strait Islands (*albiscapa* Gould 1840). The large area of sooty-grey on the breast readily distinguishes this form from that of south-eastern Australia. The underparts are more richly coloured and the back duskier. There is less white on the tail feathers. The throat is greyish-white. Condon (1951) comments on the distinctiveness of this form.

(2) South-eastern Australia from Eyre's Peninsula and Lake Gardner, through Victoria and New South Wales, to at least Rockhampton, Queensland. This form takes the name *R. fuliginosa alisteri* Mathews 1911. It is a generalized type and there is obviously gene flow throughout. A few individuals from the Melbourne area, one from Myponga, South Australia, and two from Kangaroo Island, are of the Tasmanian type. A few Sydney birds could also fit into that series.

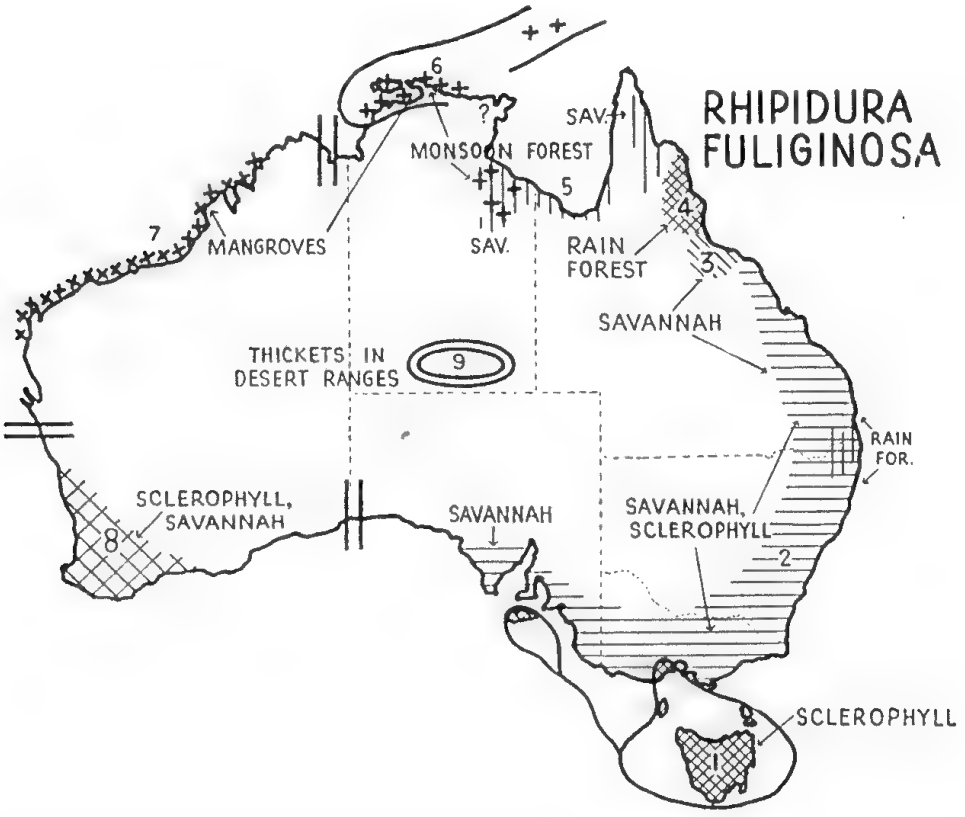


Fig. 1.—Colour forms and isolation in the Grey Fantail (*Rhipidura fuliginosa*). This grey-brown flycatcher varies in colour with rainfall and type of forest occupied (variation of this nature in birds is genotypic, not phenotypic). Thus, though the Tasmanian and Atherton populations (1 and 4) are alike, direct relationship is not involved; it is the environmental influences that are similar.

Distributional barriers are indicated by parallel lines. The population isolated in the mountains of central Australia (9) is the most distinctive. 1. *albiscapa*. 2. *alisteri*. 3. *harterti*. 4. *frerei*. 5. *phasiana*. 6. *buchanani*. 7. *subphasiana*. 8. *preissi*. 9. *albicauda*.

(3) I have not seen any birds from Inkerman (Mathew's '*harterti*' 1912, the type of which is not in the American Museum of Natural History). The area corresponds to the 'tongue' of dry country that extends through to the coast from the interior. This form is described as differing from *alisteri* in "its lighter grey coloration above, less marked band on the breast and more uniform paler abdomen coloration", a description that could well apply to various north-western populations. A female in the Australian Museum collection from Gayndah (Burnett River) could fit into the Sydney series.

(4) Cairns-Atherton area (*frerei* Mathews 1912). This rain forest form is so close to the Tasmanian one that many individuals are indistinguishable. However, the throat tends towards white, instead of being greyish-white, and the area of sooty-grey on the breast tends to be smaller.

(5) Cape York and Gulf of Carpentaria (*phasiana* De Vis 1884). These birds are paler, approaching closely to the south-eastern type. A series of six birds from Utingu and one from Jardine River (Cape York), four from Normanton, one from Burketown, two from Leichhardt River, are similar, whilst a single worn individual from Alexandria is more drab ventrally but obviously also belongs here.

(6) Melville Island and, presumably, coastal Northern Territory. Southern New Guinea, (*buchanani* Mathews 1912). This is a very drab form and is lacking in dark markings. The back is drab greyish-brown instead of dark grey. There is a mere smudge of greyish-brown on the breast (instead of sooty or mid-grey), so that the pigmented area does not stand out from the pale buff-coloured breast. Two females from Hall Sound, Papua, fit this series.

(7) Napier Broome Bay, Point Torment and Derby, Point Cloates, etc. (*subphasiana* Mathews 1912). The six individuals from the Derby area have a distinctly richer (more ochraceous) under-surface than the Melville Island birds. A bird from Napier Broome Bay, three from Point Cloates, one from North-west Cape (and for that matter some of the individuals from the Gulf of Carpentaria) are similar to them. Although the pectoral band, as noted by Mathews, is lacking in Northern Territory, Kimberley, and mid-western birds it is pronounced in two (?) immature birds from Derby and in a female from the Fortescue River.

(*7a*) Boolathanna and Carnarvon area (unnamed). Birds from here have the paler breasts of the Melville Island birds.

(8) South-western Australia (*preissi* Cabanis 1851). This form has the general appearance of a pallid version of the Tasmanian form. The breast smudge, whilst generally extensive is grey instead of sooty black and the back is paler than in Tasmanian birds (and for that matter those from New South Wales).

(9) Central Australia (*albicauda* North 1895). As noted by North (1895) this form stands apart in having "all but the two central tail feathers pure white, ..." There are two birds in the Australian Museum (one the type) and in both the tail is conspicuously whiter than in any other specimens. Otherwise their general appearance is much like that of coastal birds from the south-west.

Measurements: Wing-lengths of males (mm): Tasmania (9), 70-77 (73); King Island (1), 74; Flinders Island (2), each 74; Melbourne (8), 71-79 (75); Adelaide (3), 73-78 (75); Sydney (16), 73-79 (76); Kangaroo Island (1), 75; Bunya Mountains (2), 76 and 78 (77); Gracemere (1), 76; Cairns (5), 75-80 (78); Normanton-Burketown (2), 78; Melville Island (3), 69-71 (70); Port Torment-Derby (6), 68-76 (71); Point Cloates (2), 68 and 71 (70); Carnarvon and Boolathanna (8), 65-71 (68); south-western Australia (13), 70-77 (75); Stoke's Pass, central Australia (1), 72.

The above measurements indicate that whilst eastern and southern birds are of the same general size those from the less hospitable north-west of the continent (Melville Island to Carnarvon) are distinctly smaller. Two birds from the Gulf of Carpentaria would appear to belong to the eastern group.

Tasmanian males have tails ranging from 82-89 mm in length (mean of 9, 85); Sydney (16), 79-87 (83); south-western Australia (13), 82-87 (83); Derby (3), 76-87 (81); Carnarvon (8), 75-85 (80). The inference is that Tasmanian birds tend to have slightly longer tails than the typical, and north-western birds slightly shorter ones.

On the basis of their characteristics, and knowledge of distribution, the following Australian populations would appear to be isolated from the main stocks: Tasmania, south-western Australia, Macdonnell Range in central Australia and, possibly, those of the north-west.

North-western birds as a whole (Northern Territory to the Hamersley region) are so different from those of the east and south (pallid, reduced breast 'band', small size), as to constitute a distinct group. Variation in *R. fuliginosa* is doubtless closely bound up with rainfall and humidity. The two darkest forms are in Tasmania and the Cairns rain forests, areas of highest rainfall. The palest forms are from the dry north-west and mid-west of the continent. Melville Island birds are also very pale. Although this is an area of moderately high rainfall it is restricted to the hot summer so that its effectiveness is limited.

Nomenclature: The variation in this species, a succession of colour forms around the periphery of the continent, several of which resemble others, is most difficult to treat trinomially. Thus, the Tasmanian form (insular) of the far south-east is relatively similar to that of the Cairns rain forests (north-east Queensland), although the two are separated by a paler form and some 1,500 miles. The south-eastern and Cape York forms are not unlike each other but the dark Cairns form is interposed between them. Since the darkly pigmented Cairns type could be thought of as a 'saturated' representative of the other

eastern birds and the populations to the north and south are similar, the question arises as to whether all should not be included under the one name? Again, the two populations of dark birds (Tasmania and Cairns) could be grouped and the 'mid-grey' populations (south-eastern Australia and Cape York) receive a second name. A further course is that each of the four be given names. These difficulties, plus the varying degree of difference between successive colour forms, indicate that little importance can be attached to 'races' in species where climate affects plumage.

The following trinomial arrangement would appear to be the most satisfactory:

(1) *Rhipidura fuliginosa albiscapa* Gould 1840. Tasmania, King and Flinders Islands.

(2) *Rhipidura f. alisteri* Mathews 1911. South-eastern and eastern Australia from Lake Gardner and Eyre's Peninsula eastwards through Victoria and New South Wales, at least as far north as Rockhampton, Queensland.

(3) *R. f. harterti* Mathews 1912. Dry area around Inkerman, coastal north Queensland.

(4) *R. f. frerei* Mathews 1912. Cairns-Atherton rain forests.

(5) *R. f. phasiana* De Vis 1884. Cape York, Gulf of Carpentaria, westwards at least to Alexandria.

(6) *R. f. buchanani* Mathews 1912. Melville Island and adjacent Northern Territory. Hall Sound area of New Guinea.

(7) *R. f. subphasiana* Mathews 1912. Derby area to (?) Point Cloates. The Carnarvon birds could be included here to save introducing another name.

(8) *R. f. preissi* Cabanis 1851. South-western Australia.

(9) *R. f. albicauda* North 1895. Central Australia (Macdonnells).

The names *victoriae* Mathews 1912 (Victoria) and *whitei* Mathews 1912 (Grange, South Australia) are synonyms of the race *alisteri*.

Rhipidura rufifrons (Latham) 1801 (Rufous Fantail)
(Figure 2A.)

Range: Northern Australia from Napier Broome Bay in the north-west to Cape York, thence down the east coast to Victoria. The habitat is monsoon forest in the north and rain forest in the east.

Details of the winter dispersal of the south-eastern populations of this species are not known but they must intermix with those of Queensland at this time. Hence only material collected during spring and early summer can be used in taxonomic work.

Evolution in the *Rhipidura rufifrons* group in the Pacific has been treated by Mayr and Moynihan (1946).

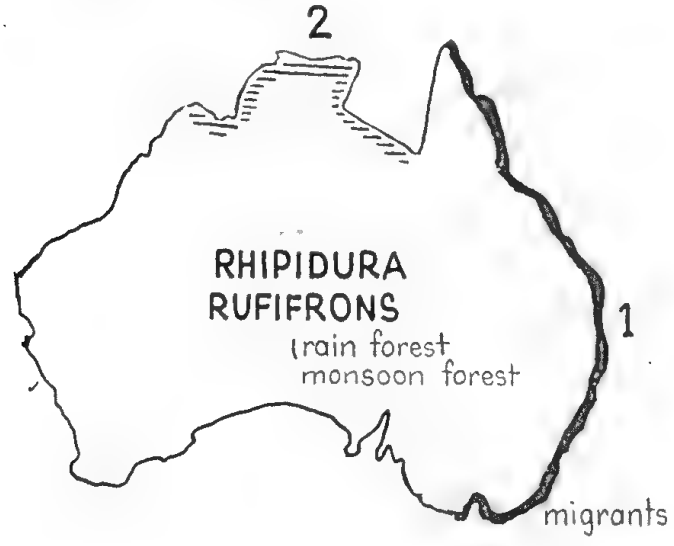


Fig. 2. — *Rhipidura rufifrons*, a rain-forest inhabitant in the east, and a riverside monsoon-forest form in the west, is broken up into two distinctive forms by the dry country at the head of the Gulf of Carpentaria. The elements probably represent twin invasions of the continent from the north. 1. *rufifrons rufifrons*. 2. *rufifrons dryas*.

Specimens: Melbourne area, Sydney, Gosford, Tweed River, Blackall Range and Bunya Mountains (all spring series); Inkerman (1—September); Wide Bay-Cairns (good series, mostly winter); Cape York (Utingu and Cable Station—good breeding season and good winter series). Small series were seen from the Gulf of Carpentaria, including a July male from Burketown, female from the Gregory River (July), an undated male from Georgetown, and various individuals from Normanton (January male, February female, October female, etc.). Northern Territory specimens: Van Diemen Gulf, Anson Bay (both series); Alligator River (1); Melville Island (1); Darwin (1); Parry's Creek (1—Mathews female 'type' of *parryi*).

Geographic Variation: Birds fall into two main series: eastern and north-western. Northern Territory birds have a prominent white (instead of barely discernible grey) tipping to the tail feathers, a general reduction in scale-like breast markings (although this is variable), and tendency towards paler breasts (reduction in buff colouring). The tail is the main character separating the two groups. In eastern birds the terminal paleness of the feathers (with the exception of the centralmost two, where it may not be developed at all) is some 5-10 mm in width. In Northern Territory birds the centralmost two feathers are finely tipped with white (3-5 mm) but it is extensive on the other feathers (15-25 mm). The two forms thus differ both in the tone and extent of the terminal markings.

The Gulf birds are of the north-western type but have intermediate tendencies, *e.g.*, the breast pattern approaches that of the eastern specimens; the white tipping to the tail is frequently as extensive as in Northern Territory birds but may be narrower (*e.g.*, 15 mm instead of 25 mm). The single male from Watson River, near the tip of Cape York, but on its western side, is of this type.

The range of the two colour-types is shown on Figure 2.

Measurements of adult males are as follows:

	Wing	Bill	Tail
	mm	mm	mm
Melbourne (6)	71–76 (74)	8.0–8.6 (8.2)	80–86 (82)
Sydney (4)	72–78 (75)	7.8–8.7 (8.3)	81–86 (84)
Cairns (6)	71–77 (74)	8.2–8.8 (8.5)	80–88 (86)
Cape York (4)	73–75 (74)	8.2–8.5 (8.3)	82–85 (83)
Gulf of Carpentaria (6)	70–72 (71)	8.6–9.2 (9.0)	87–93 (90)
Northern Territory (6) (Van Diemen Gulf, etc.)	68–75 (72)	8.7–9.2 (8.9)	88–94 (92)

The inference to be drawn from these figures is that the populations frequenting the north-west of the continent and the Gulf of Carpentaria have longer bills, longer tails, and slighter shorter wings, than those of the east and north-east.

The following are synonyms of *rufifrons*: *inexpectata* Mathews 1912 (Dandenongs); *intermedia* North 1902 (Bellenden Ker); *kempi* Mathews 1912 (Cape York); and *parryi* Mathews 1912 (Parry's Creek) is a synonym of *dryas*.

Speciation and Isolating Barriers: The two Australian forms of *Rhipidura rufifrons* probably represent twin invasions from New Guinea. Within Australia the two occupy relatively different habitats, the north-western one being adapted to dry conditions. It has obviously secondarily spread eastwards around the shores of the Gulf, possibly as far as the Watson River.

Nomenclature: *Rhipidura rufifrons rufifrons* (Latham) 1801: East coast from Victoria to Cape York.

Rhipidura rufifrons dryas Gould 1842: Napier Broome Bay to Gulf of Carpentaria and western Cape York.

Rhipidura rufiventris isura Gould 1840 (Northern Fantail)

The Australian range of *Rhipidura rufiventris* extends from Broome in the north-west, along the north coast to about the Burnett River (Gayndah) Queensland. The habitat is monsoon forest, mangrove, and rain forest. It is not known whether or not the range is continuous across the head of the Gulf of Carpentaria but the species has been collected on the Leichhardt River.

Specimens: Broome (one young bird); Derby (series); Parry's Creek (3); Ord River (1); coastal Northern Territory, including Katherine River, King River, Daly River, Brocks Creek, Alligator River (series); Melville Island (series); Leichhardt River (1); Claudie River on Cape York (1); Cairns, Rockingham Bay, and Mount Elliott (series); Gayndah, Burnett River (1).

Geographic Variation: The material does not reveal any consistent geographic differences. In the west and east, Melville Island and Cairns birds are similar, though some of the former are paler dorsally and ventrally.

Measurements of series of adult males from various localities fail to indicate any geographic size differences:

	Wing Length mm	Tail Length mm
Derby-Wotjulum, *i.e.*, 60 miles north of Derby (6)	84–92 (86)	78–82 (81)
Parry's Creek (3)	81–87 (85)	80–86 (83)
Melville Island (4)	85–91 (87)	76–82 (80)
South Alligator River (2)	82, 86	79, 80
Cape York (1)	88	83
Cairns-Rockingham Bay (7)	80–89 (85)	79–86 (82)

Nomenclature: The type specimen of Mathews' '*tormenti*', 1912 (Point Torment) has not a "longer tail" as stated, but has a very long bill. At any event the other material from this locality is typical. Mathews' '*macgillivrayi*' 1916 from the Leichhardt River is similar to Rockingham Bay birds (Ramsay's '*superciliosa*' 1875). Variation in bill width, given as a race character by Mathews, does occur, but it is not consistent from place to place and does not lend itself to accurate measurement.

Only one race of *Rhipidura rufiventris* can be recognised in Australia.

Rhipidura leucophrys (Latham) 1801 (Willie Wagtail)

(Figure 3.)

This species ranges widely over Australia, occupying most forest habitats with the exception of the denser jungles and mulga desert. In the interior it is found mostly along the watercourses. The species is a casual visitor to Tasmania.

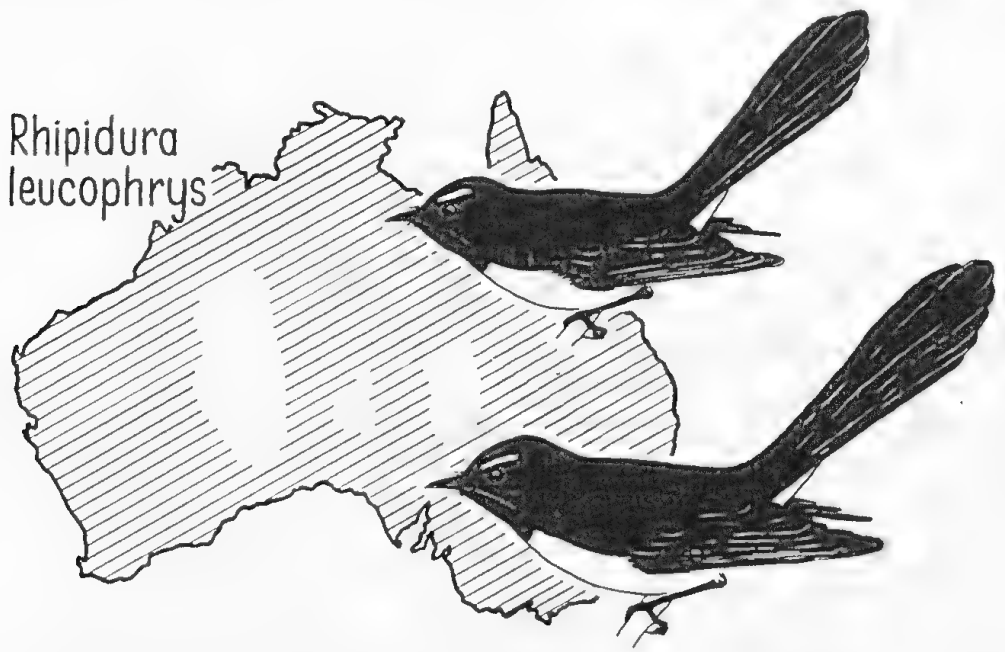


Fig. 3.—Black and white Fantail (*Rhipidura leucophrys*), to show south-north size cline (Bergmann Effect). Southernmost and northernmost populations differ in size by 11 per cent.

Specimens: Melbourne (series); Sydney (series); odd specimens from coastal Queensland; Cape York (3); Normanton (series); coastal Northern Territory, including Alligator River, Van Dieman Gulf, Eureka—series; Parry's Creek (series); Napier Broome Bay (1); Forrest River (2); Canning Stock Route, Wells 34 and 7—one each; Derby (series); Point Cloates (3); mid-western Australia, mostly Yalbalgo and Boologorroo—2; south-western Australia, Broome Hill, etc.—series; central Australia (2); Birdsville (1); Alexandria (3).

Geographic Variation: This species does not vary in colour geographically.

Northern populations of *Rhipidura leucophrys* are distinctly smaller than southern ones (judged by changes in wing-length), as will be seen from the following series of adult males:

	Wing mm	Tail mm
Eastern:		
Melbourne area (5)	97–104 (101)	97–106 (101)
Sydney area (12)	96–104 (99)	97–105 (100)
Bourke (3)	95– 99 (97)	97–102 (99)
Normanton (4)	90– 95 (92)	92– 97 (94)
Cape York (3)	91– 96 (93)	95– 98 (97)
Western:		
South-western Australia (8) (Albany, Broome Hill)	92–101 (98)	94–102 (97)
Mid-western Australia (3) (Yalbalgo and Boologorroo)	93–101 (97)	97–102 (98)
Point Cloates (2)	96, 99 (96)	96, 99 (98)
Derby (3)	93– 98 (96)	96–100 (98)
Parry's Creek (3)	94– 96 (95)	96– 99 (98)
Forrest River (1)	97	98
Coastal Northern Territory (6) (Alligator River, Van Diemen Gulf)	91– 96 (94)	91– 99 (93)
Birdsville (1)	103	99
Alexandria (1)	96	96

As there are no breaks in the distribution of *R. leucophrys* it would seem certain that size variation is clinal. (Fig. 3.)

Nomenclature: I can see no basis for Mathews' '*utingu*' 1912 (Cape York) and '*carteri*' 1912 (South-western Australia) both named on size grounds. The best procedure would be simply to name northern and southern ends of the cline, *viz*:

Rhipidura leucophrys leucophrys (Latham) 1801: Southern Australia.

Rhipidura leucophrys picata Gould 1848: Northern Australia.

Seisura inquieta (Latham) 1801 (Restless Flycatcher)
(Figure 4.)

This species extends throughout the continent where there is forest of the open type. The habitat is savannah woodland (with intrusions into savannah grassland) and dry sclerophyll forest. It avoids desert and semi-desert areas (Serventy and Whittell 1948; Terrill and Rix (1950)) and is absent from the mountain ranges of central Australia where many forest species have isolated populations—note absence from field lists of Whitlock (1924), Jarman (1953), and those of the writer. In fact, *S. inquieta* is absent from the broad belt of country extending across the 'waist' of the continent from the Sharks Bay—Hamersley region of the west (Carter 1921-22 in Mathews 9:66) through to western Queensland. This has the effect of dividing the species into a southern stock and one living in the savannah of the north (recorded as "rare" as far south as Banka Banka, 60 miles north of Tennant Creek (Jarman, 1944)). The two stocks may be in contact in the east of the continent but certainly are not in either the centre or west.

Specimens: Melbourne (series); Victorian mallee (series); Sydney area (series); Kangaroo Island (4); coastal South Australia (3); Bourke (2); Charleville (1); Emu Vale (2); Gracemere (2); Mackay (2); Alexandria (1); Borroloola (1); Normanton (series); south-western Australia (series); Broome (2); Derby (series); Parry's Creek (series); Napier Broome Bay-Forrest River (5); coastal Northern Territory-Van Diemen Gulf, Alligator and Daly Rivers (series).

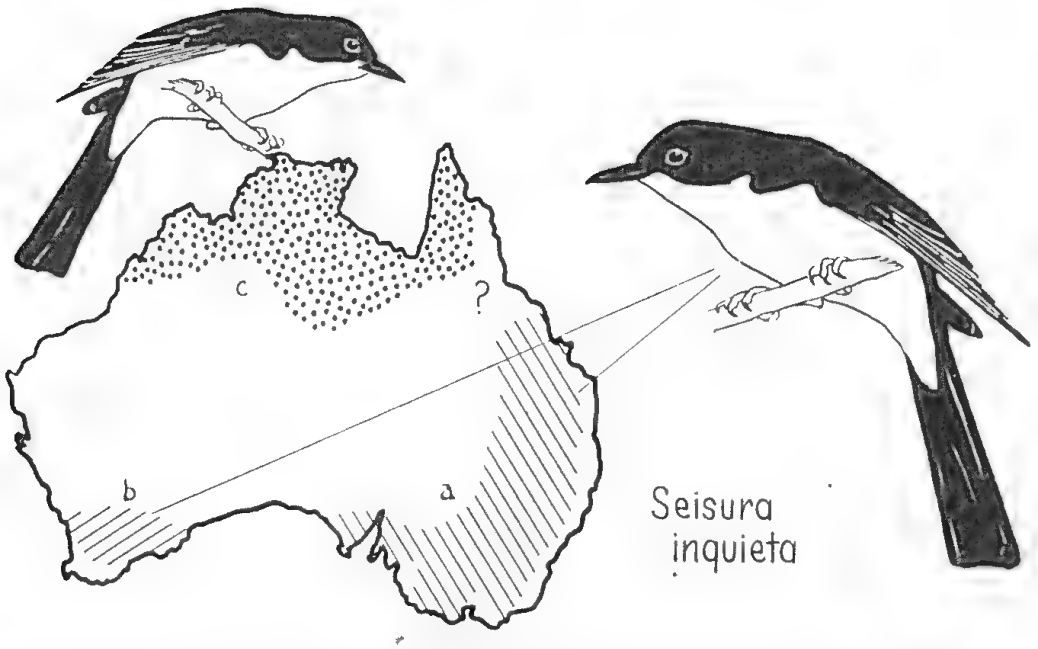


Fig. 4. South-north size variation in the Restless Flycatcher (*Seisura inquieta*). Southern and northern populations are isolated. Size trends are the same as in *R. leucophrys* but they are so much greater (20 per cent.). a. *inquieta*. b. *westralensis*. c. *nana*.

Geographic Variation: This species does not vary geographically in colour.

Wing, bill, and tail lengths vary strikingly from south to north, as will be seen from the following series of adult males:

East (*south to north*) :	Wing (mm)	Tail (mm)	Bill (mm)
Melbourne area (4)	101–108 (104)	92–96 (94)	15.2–15.5 (15.3)
Victorian Mallee (4)	101–108 (104)	93–96 (95)	15.1–15.8 (15.5)
Sydney area (9)	102–108 (106)	92–97 (95)	14.3–15.5 (14.9)
Bourke (1)	107	93	15.5
Emu Vale (1)	105	93	15.5
Gracemere (1)	103	90	15.2
Mackay (1)	101	88	14.8
Charleville (inland) (1)	101	87	14.6
Normanton (5)	83–90 (86)	75–79 (78)	13.0–13.3 (13.1)
Booroloola (1)	89	80	12.7
Alexandria (1)	about 100	92	14.0
West (*southern*) :			
Kangaroo Island (3)	106–110 (108)	92–94 (92)	15.1–16.0 (15.5)
Coastal South Australia (2)	103, 110	92, 92	15.2, 15.4
South-western Australia (11)	107–113 (110)	93–103 (99)	15.4–16.4 (16.0)
(*northern*) :			
Broome (2)	88, 89	77, 86	12.0, 12.2
Derby (5)	84–93 (89)	77–82 (80)	12.0–13.0 (12.6)
Parry's Creek (3)	83–88 (86)	76–85 (80)	12.3–12.8 (12.7)
Napier Broome Bay and Forrest River (3)	90–94 (92)	80–85 (84)	12.2–13.1 (12.8)
Coastal Northern Territory (6)	83–90 (88)	74–82 (78)	12.8–13.5 (13.1)

It will be seen that the northern populations of *S. inquieta* are strikingly smaller than those from the south, in all dimensions (Fig. 4). Within the latter the south-western stock is larger than the south-eastern one and confirms the racial status of these birds (Mathews' *westralensis* 1912). The series does not, however, support the existence of a distinct form in the Derby area (Mathews' '*rogersi*' 1912, said to be smaller than *nana* and constituting the smallest 'race'). Mathews' '*nea*' 1912 from the Dawson River, "intermediate in size" between

the southern and northern forms, is not justified for birds from central Queensland are of the southern type. It is permissible only to name end forms so that *rogersi* is a synonym of *nana* and *nea* of *inquieta*.

Nomenclature: The following races occur in *S. inquieta*:

Seisura inquieta inquieta (Latham) 1801: Eastern section of continent from South Australia to central Queensland.

S. inquieta westralensis Mathews 1912: South-western Australia (an isolate).

S. inquieta nana Gould 1870: Northern Australia (Kimberleys to north Queensland).

Isolation and Speciation: The chief interest of *S. inquieta* lies in the isolation of its components and the effect of this on geographic variation. The large south-western form ("b" Fig. 4) is isolated from the birds in south-eastern Australia ("a", Fig. 4) by the arid Nullarbor Plain (gap in range perhaps 1,000 miles) and from the small form in the Kimberleys ("c", Fig. 4) by the desert tracts extending to the sea south of Sharks Bay and in the Ninety Mile Beach region (range gap of perhaps 1,200 miles). It is interesting to note that in *S. inquieta* the northern form has not got southwards across the latter barrier to occupy the savannahs of the Hamersley region, which is the case with many species.

The gap in the range of the 'Scissors-Grinder' through the centre of the continent (southern Flinders Range to Banka Banka) is in the region of 1,200 to 1,300 miles. Since the vegetation maps (Prescott 1931) indicate that savannah woodland extends continuously up the east of the continent it is to be expected, in this section of the continent, that large southern and small northern forms will be in contact with each other. There is no information on this. It will be noted, however, that as far north as Mackay the birds are relatively large but that at Normanton (some 600 miles to the north-west) they are very small. This is the critical area for investigation but, not only have we no specimens from there but there is no evidence as to whether or not the range is continuous between these points. It might, however, be borne in mind that the treecreeper (*Climacteris picumnus*) has distinctive southern and northern forms with similar distributions to those of *S. inquieta*. The former extends north at least to Rockhampton and the latter inhabits the Normanton-Cape York-Cardwell triangle. There can be no doubt that isolation has been involved in the production of these (Keast 1957). Likewise *inquieta* and *nana* must have developed in isolation. As in *Climacteris* the barrier is possibly the tract of arid country that extends from inland to the coast in the vicinity of Townsville-Inkerman.

It is common for sedentary Australian birds with an extensive range to be smaller in the warmer north. Mostly the differences are not great (*e.g.*, 11 per cent. in *Rhipidura leucophrys*) and there is a cline connecting them; that is, it is simply an expression of Bergmann's Rule. It is worthy of note that in *S. inquieta*, where the northern and southern populations are isolated, the differences are greater (20 per cent.).

Piezorhynchus alecto (Temminck et Laugier) 1827. (Shining Flycatcher)

This species ranges along the coastline of northern Australia from Derby to about Hinchinbrook Island. It is an inhabitant of the undergrowth and brushes in the vicinity of creeks and rivers and of the dense mangrove forests.

Specimens: Point Torment (series); Napier Broome Bay (3); Melville Island (series); coastal Northern Territory, including Post Essington and the Mary, Margaret, King and Alligator Rivers (series); Groote Eylandt (1); Cape York-Cable Station, Peak Point, Piara, Patterson Creek, Somerset (series); Cooktown (1); Cairns and Cardwell (series); Hinchinbrook Island (1); Torres Strait (2).

Geographic Variation: Three distinctive colour-types occur:

(1) Point Torment area (*tormenti* (Mathews) 1912).

The bill is long and narrow and the abdomen is sooty black in the male. The females are striking: dark-grey brown on the top of the head with only the faintest sheen, instead of the sheeny-black of those from elsewhere. This possibly represents the continuance of the immature plumage into the adult.

(2) Napier Broome Bay-Melville Island and (probably) Groote Eylandt (*nitida* Gould) 1840). In the males the bill form and colour of the abdomen are intermediate between *tormenti* and *wardelli*. Melville Island females tend to be slightly darker brown on the back than Cape York birds but some Cape York individuals resemble them.

(3) Torres Strait, Cape York, south to Hinchinbrook Island, Queensland (*wardelli* Mathews 1911). This is a short-billed form, although occasional longer-billed individuals do occur (one male had a bill 14.1 mm in length). In males the black of the abdomen has a sheen to it, lacking in *tormenti*.

Wing and bill measurements of males from the several localities are as follows:

	Wing (mm)		Bill (mm)	
Point Torment (3)	85-87	(86)	15.2-15.8	(15.6)
Napier Broome Bay (3)	87-92	(89)	14.7-14.8	(14.8)
Northern Territory coastal (4)	87-91	(89)	13.6-14.4	(14.1)
Melville Island (3)	84-89	(87)	13.5-14.5	(14.0)
Groote Eylandt (1)	87		13.9	
Cape York (7)	84-91	(88)	13.2-13.9	(13.6)
Cairns (7)	86-90	(88)	12.7-13.4	(13.0)
Hinchinbrook Island (1)	89		13.1	
Banks Island, Torres Strait (2)	90, 93		13.8, 14.2	

There is apparently no significant geographic variation in wing length (and tail length). Bills vary strikingly, maximum size being reached in the Point Torment form and minimum in the birds from Queensland, that is at the two extremes of range. The occurrence of distinct colour forms in the north-west and east is indicative of isolation of these two stocks. The case is a parallel to that of *Pachycephala simplex* and infers that there is a gap in the richer mangrove forests in the Gulf of Carpentaria.

Nomenclature: The races *tormenti, nitida, wardelli,* warrant recognition. Mathews' '*melvillensis*' 1912 ("much wider, heavier bill") and '*campbelli*' 1912 from Cape York, said to have a "much narrower bill" and to be smaller, are direct synonyms of *nitida* and *wardelli* respectively. These populations certainly do not merit names.

Piezorhynchus alecto tormenti (Mathews) 1912: Point Torment area of Kimberleys.

P. alecto nitida Gould 1840: Napier Broome Bay to Melville Island and (probably) Groote Eylandt.

P. alecto wardelli Mathews 1911: Islands of Torres Strait, Cape York, south to Hinchinbrook Island.

Myiagra rubecula (Latham) 1801. (Leaden Flycatcher)

(Figure 5.)

The Australian range of this species extends from west of Melbourne, northwards along the coast to Cape York, thence west to about Derby in the Kimberleys. It is a species of the coastal forests. Eastern and western stocks are probably isolated. The south-eastern populations are migrants.

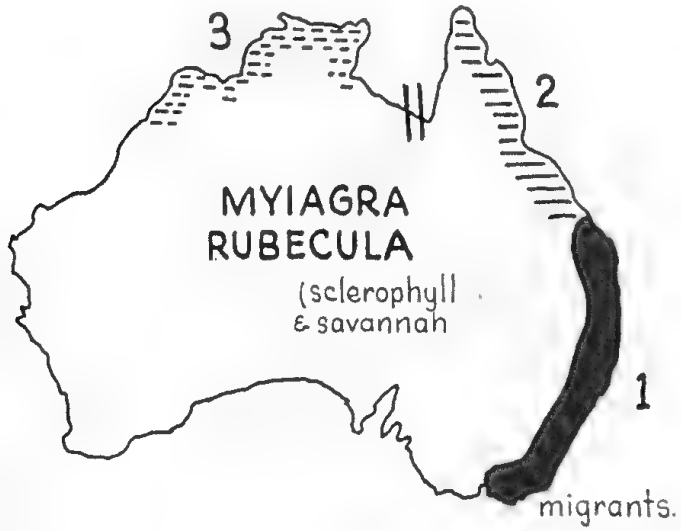


Fig. 5. — *Myiagra rubecula*, a sclerophyll-savannah species, in addition to having an isolated form in the north-west, has undergone minor differentiation in the east. Like *R. rufifrons* the south-eastern population is migratory. 1. *rubecula rubecula*. 2. *rubecula yorki*. 3. *rubecula concinna*.

Specimens: Melbourne (series); Sydney (series, including two wintering males); odd birds collected at various times of the year from a variety of Queensland localities, including Fraser Island, Burnett River, Mackay, Inkerman, Hinchinbrook Island, Cardwell, Bartle Frere (Cairns), Cooktown, and Cape York. In the north-west specimens have been seen from Napier Broome Bay (3); Parry's Creek (series); Melville Island (series).

Geographical Variation: Birds collected in late spring and summer (*i.e.* in breeding season) may readily be divided into three series:

(1) South-eastern breeding populations (*rubecula* (Latham) 1801) in which the males are characterized by pale lores. The bill is large and wide (length in Sydney birds, 11.3-11.8 mm (mean of eight, 11.6). The northern limits of this form cannot be stated, but it presumably grades into *yorki*.

(2) North-eastern populations, Cape York to about Fraser Island (*yorki* Mathews 1912), with black lores and a bill like *rubecula*. There are black-lored males from Cape York (various times of the year); Bartle Frere, Cardwell, Inkerman, Hinchinbrook Island, Burnett River and Fraser Island (spring and summer).

(3) Kimberleys and Northern Territory (*concinna* Gould 1847) with black lores and a small, narrower bill (length in Northern Territory-Melville Island birds, 10.2-10.8 mm the mean of six being 10.7).

Wing-length measurements for adult males (mm) from various parts of the range in late spring and summer are as follows:—Melbourne (4), 80-84 (82); Sydney (10), 77-83 (80); Fraser Island and Burnett River (2), each 79; Rockingham Bay (1), 80; Cape York (4), 77-80 (78); Darwin (2), 73 and 74; Melville Island (3), 74-79 (76); Parry's Creek (3), 73-75 (74); Derby (1), 76. These figures indicate that, though there is probably a minor south-north cline of decreasing size in the breeding populations of *M. rubecula* in the east the north-western stocks are distinctly smaller; that is to say the changes in size reflect those in bill length.

The fact that the migratory south-eastern race of *M. rubecula* is distinguishable from that inhabiting the north-east means that it should be possible to accurately plot the winter range of this form. Males with pale lores (American Museum of Natural History Collection) have been seen as follows: Cape York (April, May, June, September, October), Cooktown (October), and Mackay (September). It will be noted that Mayr (1941) records *M. rubecula rubecula* as extending to the Daru-Fly River area of New Guinea on migration.

Nomenclature: The forms *rubecula, yorki,* and *concinna* merit recognition, with *yorki* the least differentiated of the three. I have seen the type specimens and agree with the action of Mathews in placing his *ringwoodi* 1912 under *rubecula,* and *melvillensis* 1912, and *broomei* 1912, under *concinna.*

Myiagra rubecula rubecula (Latham) 1801: Coastal forests of eastern Victoria, New South Wales, presumably grading into

M. rubecula yorki Mathews 1912: Fraser Island to Cape York (breeding).

M. rubecula concinna Gould 1847: Kimberleys and Northern Territory.

Myiagra cyanoleuca (Vieillot) 1818.. (Satin Flycatcher)

This species extends through the coastal mountain forests of the east from Tasmania to Cape York. It is a migrant and winter visitor to New Guinea, New Britain, and adjacent islands (Mayr 1941).

Specimens: Tasmania (4), Melbourne (series), Sydney and central coastal New South Wales (series), Cairns (series), Cape York (series).

Geographic Variation: There is no indication of geographic colour variation in this species. Wing-length measurements of adult males (mm) from various parts of the range are as follows: Tasmania (2), 89 and 94; Melbourne area (4), 89-92 (90); Sydney and central New South Wales (5), 87-92 (90); Cairns (4), 86-90 (88); Cape York (4), 85-92 (88). I do not agree that Mathews' '*robinsoni*' 1912 (Cooktown, north Queensland) is duller (less glossy) in coloration.

No races can be recognised in *M. cyanoleuca.*

Myiagra ruficollis (Vieillot) 1818. (Broad-billed Flycatcher)

This species extends through the coastal regions of tropical northern Australia from Point Torment to Cape York. The habitat is mangroves. Beyond Australia the species extends to southern New Guinea and Timor.

Specimens: Point Torment (series); Melville Island (4); Normanton (series), Cape York (2).

Geographic Variation: This species does not vary geographically within Australia. Various races have been described by Mathews: *kempi* 1912, Cape York ("narrower and more pointed bill"); *cooperi* 1912, Melville Island ("darker coloration and broader bill"); *tormenti* 1912, Point Torment ("lighter above and narrower bill"). Series fail to support such descriptions and these names must be reduced to synonymy. Mayr (1941) and H. G. Deignan (*Results, Arnhem Land Expedition;* unpub.) correctly place Australian birds under the race *mimikae* Ogilvie-Grant 1911, of New Guinea.

Machaerirhynchus flaviventer Gould 1851. (Boat-billed Flycatcher)

The Australian range of this species extends from Cape York to Cardwell. It is strictly an inhabitant of the rain forest and hence the range is broken by the 150 mile-wide front of dry country in southern Cape York.

Specimens: Series from Cape York and Cairns.

Geographic Variation: Birds from the two areas are distinctive. Males from Cairns (*secundus* Mathews 1912) have the back heavily blotched with black instead of being dark olive above like those from Cape York (*flaviventer* Gould 1851). Females from the former area tend to be deeper green dorsally. Wing-length measurements of adult males (mm) are as follows: Cape York (4), 56-60 (59); Cairns-Cardwell (7), 58-61 (60). The distribution of these forms corresponds to the isolated tracts of rain forest in northern Cape York and Atherton areas respectively.

As would be expected the Cape York stock approaches the colouring of *xanthogenys* Gray 1858, from southern New Guinea, in which form there is, however, some development of black on the back.

Nomenclature: *Machaerirhynchus flaviventer secundus* Mathews 1912: Cairns-Atherton area.

M. flaviventer flaviventer Gould 1851: Cape York.

Arses kaupi Gould 1851. (Pied Flycatcher)

This species is confined to the Cairns-Cardwell rain forest area.

Specimens: Approximately a dozen from the general Cairns area.

Geographic Variation: It does not vary geographically. Adult males vary in wing-length from 80 to 83 mm (mean of 6, 82).

Mack (1931) has discussed the relationship of this species with *A. telescophthalmus lorealis.*

Arses telescophthalmus lorealis De Vis 1895. (Frill-necked Flycatcher)

The distinctive Australian population of this widely-ranging New Guinea species is confined to the rain forest north of Coen, Cape York.

Geographic Variation: This form does not vary within Australia. Its relationships with the New Guinea stock has been dealt with by Mack (1931 and 1953) who draws attention to the closeness of *lorealis* to *aruensis* from the Aru Islands. It is important, however, to note the persistence of the brown female form in the latter (coloured plate in Gould, 1875-1888).

Monarcha melanopsis (Vieillot) 1818. (Black-faced Flycatcher)

The Australian range of this species is from Victoria (where it is rare) to Cape York. The habitat is rain forest. The southern birds are migrants, the species having a wintering area from south-eastern New Guinea to Fergusson, Goodenough, and the Trobriand Islands (Mayr 1941).

Specimens: Cunningham, Victoria (1); Sydney area (series, breeding season); odd birds from Richmond River, Tweed River, Macpherson Range, Bunya Mountains (breeding season); Cairns and Cardwell (series, September, December, January, February); Cape York (4 in February, one without date).

Geographic Variation: There are no consistent colour differences as between birds collected in spring-summer at the southern and northern extremities of range.

Wing-length measurements for adult males (mm) from various parts of the range are as follows: Victoria (1), 89; Sydney area (9), 90-97 (94); northern New South Wales (3), 93-97 (95); Cardwell-Cairns (7) 87-91 and one December bird 95 (90); Cape York (3), 85, 86, and 93, respectively. The Cape York birds were collected in February and should be breeding stock. Hence a minor south-north size cline is indicated. An undated male has a wing measuring 96 mm and is obviously a migrant from the south. There would not appear to be geographic variation either in bill- or tail-length in *M. melanopsis*.

The smaller size (as judged by wing-length) of the northern populations of *M. melanopsis* can be recognized by accepting the name *pallida* Mathews 1916. Since *M. melanopsis* breeds only in rain forest there is probably a degree of genetic isolation between birds inhabiting the two large sections of this vegetation association, the one in Cape York and Cairns, the other in southern Queensland and New South Wales.

Nomenclature: *Monarcha melanopsis melanopsis* (Vieillot) 1818: Victoria to southern Queensland.

Monarcha melanopsis pallida Mathews 1916: Cardwell to Cape York.

Monarcha frater Sclater 1874. (Black-chinned Flycatcher)

This is another New Guinea species with a 'toe-hold' in the Claudie River district of northern Cape York. It has long held the name '*Monarcha canescens*' in Australian literature and been the subject of debate as to whether it is a good form or only an aberration.

The difference between *Monarcha frater* and *M. melanopsis* is not great. As far as I can determine *M. melanopsis* has not been recorded breeding in New Guinea. As, however, an endemic race is listed in the south (Merauke to the Oriomo River (Mayr 1941) the specific status of *M. frater* would appear to be assured.

Geographic Variation: Only a couple of Australian specimens of *M. frater* have been collected. There are single specimens (labelled '*canescens*') in the American Museum of Natural History from 'Cape York' (a female collected on 27 February), Claudie River (male, 16 February, the type of Mathews' '*claudia*') and a male labelled 'Cape York' (17 March, the type of Mathews' '*kurandi*').

Much more material is needed before an adequate comparison of Australian and eastern New Guinea populations of *M. frater* can be made. The two would appear similar, however.

Monarcha trivirgata (Temminck) 1829. (Spectacled Flycatcher)

The Australian range of this species extends from Cape York to northern New South Wales (occasionally breeding as far south as Gosford). The habitat is rain forest, but in places the bird frequents mangroves. The southern populations are migratory.

Specimens: Richmond River (2); Tweed River (2); Gracemere (2); Port Denison near Bowen (2); Inkerman (1); Cairns (series); Cooktown (1); Cape York, including Piara, Cable Station, Somerset, Utingu, Pinkenya (total of about 15); Banks Islands, Torres Strait (3).

Geographic Variation: There are two colour-types in Australia. The southern one (*gouldi* Gray 1860) ranges from New South Wales to the base of Cape York. In it the rufous of the breast extends down over the flanks. The northern form (*albiventris* Gould 1866) has a white abdomen, the rufous ending abruptly on the breast. In the American Museum of Natural History there are white-breasted birds from Torres Strait, Piara, Cable Station, and Somerset. Birds from Utingu and Pinkenya (Cape York) could fit into the southern type, having coloured flanks but with the white extending well on to the rufous area. Possibly these are migrants. Cooktown birds are like those from the south. Mack (1953) lists *albiventris* from Portland Road, Claudie River, Iron Range, Tozer Gap, Peach River, Upper Nesbit River, and Rocky Scrub, and *gouldi* from Shipton's Flat and Mount Finnegan in the Cooktown area.

Wing-length measurements (mm) of adult males of *Monarcha trivirgata* are as follows:

Northern New South Wales (3), 76-79 (77); Gracemere (1) 80; Port Denison (2), each 78; Cairns (11), 75-82; Cape York—*albiventris* (5), 73-76 (75); Torres Strait (2), 72 and 75. A south-north cline of decreasing size is indicated

Mathews' '*stalkeri*', 1916 from Inkerman has already been reduced to synonymy by the author. It is not significantly "pale" as stated in the description.

M. trivirgata albiventris represents a second invasion of the continent from the north. It is presumably isolated as a breeding unit from the southern stock by the dry tract (some 150 miles wide) as the base of Cape York. This, a barrier to many species, is discussed by Mack (1953).

Nomenclature: *Monarcha trivirgata gouldi* Gray 1860: Central coastal New South Wales to southern Cape York.

M. trivirgata albiventris Gould 1866: Northern Cape York.

Monarcha leucotis Gould 1850 (White-eared Flycatcher)

This species extends through the coastal forests of Queensland from Cape York to about Brisbane, being rare at the extremities. Its rarity on Cape York is stressed by Macgillivray (1921-22 in Mathews 9: 91) and Mack (1953).

Specimens: Brisbane (1); Fraser Island (1); Gracemere (2); Port Denison (2); Cairns (6).

Geographic Variation: This species does not vary geographically in colour and I disagree with Mathews that the birds from Gracemere (*'gracemeri'*) have a darker coloration. Wing-length measurements (mm) of adult males are as follows: Brisbane (1), 71; Port Denison (2), 72, 73; Cairns (4), 71-74 mm (72). Mack (1953), who has examined a Cape York specimen, does not admit any races in *M. leucotis* and I am in agreement with him.

Microeca leucophaea (Latham) 1801 (Brown Flycatcher)

This flycatcher has a wide range through continental Australia and has an outlying population in southern New Guinea. Sclerophyll forest and savannah woodland are the main habitats. Rain forest, at the one extreme, and desert mulga on the other, limit distribution. Even so, *M. leucophaea* extends well out into the drier areas, *vide* Kalgoorlie and Balladonia in the south-west (skins), east to Ooldea and north to Donald's Plains, Innamincka and Mount Ive in South Australia (Terrill and Rix 1950); and south to Alexandria (skins) and Banka Banka, near Newcastle Waters, in the Northern Territory (Jarman 1944). It is absent from a vast tract of country 600 to 800 miles wide extending from the west coast, through central Australia, to western Queensland. The species can best be thought of as being composed of a series of southern and a series of northern populations connected by way of Queensland. The south-western stock is apparently isolated to-day (Serventy and Whittell 1948).

Specimens: Melbourne area (series); Victorian mallee (series); south-eastern South Australia (series); south-west corner (series); Lake Dundas (1); Kalgoorlie (1); Balladonia (1); Innamincka, central Australia (1); Bourke (2); Dubbo (1); Emu Vale (2); Gracemere (2); Dawson River (1); Bowen (1); Walsh River (1); Cairns (2); Normanton (series); Alexandria (2); Alligator River (3); Forrest River (1); Parry's Creek (4); Maple Downs Station (1); Derby (series).

Geographic Variation: This occurs in overall coloration (back paler, ventral surfaces "whiter" in drier areas) and in the extent of white on the tail. In general coloration birds from the better-watered areas of the south-east and east (Sydney, Melbourne and Adelaide, south-eastern Queensland, north to Cairns) are similar. South-western birds are of the same general tone but frequently have a brownish tinge on the ventral surface. Interior and northern birds are distinctly paler (browner) dorsally, and whitish below (lack greyish suffusion). In New South Wales birds from Dubbo are only slightly paler than those from Sydney but the Bourke specimens are distinctly so. The specimen from Innamincka, central Australia, is very pale. Kimberley, Northern Territory, and Normanton birds are pale on the back, but within the Kimberleys a minor clinal change is evident (*e.g.*, Forrest River birds are slightly darker above than those from Maple Downs inland and Derby-Broome to the south). The Normanton birds tend to have a whiter underside than those from the Kimberleys, lacking the buff-coloured wash on the chest.

In respect to tail coloration, birds from the south-east (Adelaide, Melbourne, Sydney, Bourke, Innamincka, south Queensland) have a 'moderate degree' of white. It is markedly reduced in birds from the south-west of the continent, Eyre Peninsula (Condon 1950), and the Victorian mallee. The difference is described by Condon:

> . . . .the two outer shafts of the tail are not pure white; the outermost rectrix is white on the outer vane while the basal half of the inner vane is very dark grey, the second rectrix is dark grey except for a white tip.

Increased white is manifest in northern birds (Kimberleys, Northern Territory, Normanton, and Cairns), birds from central Queensland being transitional to the south-eastern type.

Typical Sydney birds have the outermost rectrix pure white, the second pure white or dark only on the basal section of the inner vane, and the third with a minor to moderate broad tipping of white. In northern birds the third rectrix varies from having a moderately-broad tipping of white to being almost pure white.

Specimens of the New Guinea form of *M. leucophaea* (*zimmeri*) are distinctive, having a cream-yellow wash ventrally, a yellowish wash dorsally (visible in some Normanton birds), and a broad bill.

Wing-length measurements (mm) of adult males are as follows: Melbourne area (4), 89-92 (90); Victorian mallee (3), 89-92 (90); Sydney area (10), 89-94 (91); Dubbo (1), 87; Bourke (2), 88 and 90; Innamincka, central Australia (1), 89; Emu Vale (1), 89; Gracemere (1), 88; Cairns (2), 83 and 85; Normanton (7), 80-84 (82); Alligator River (2), 77 and 79, Maple Downs (1), 84; Forrest River (1), 76; Parry's Creek (3), 78-80 (79); Derby (6), 76-82 (78); south-west corner (4) 87-91 (88). The smaller size of the northern populations is apparent.

The bill, because of its small size, is a difficult character to measure in *M. leucophaea*. There is little doubt, however, that birds from the north also have small bills; Sydney males (10), 8.6-9.2 mm (8.9); Cairns (2), 8.4 and 8.5 mm; Derby (6), 8.2-8.7 mm (8.4).

Nomenclature: Seven Australian races are given for *Microeca leucophaea* in the latest list of Mathews (1946). These are as follows: *leucophaea* (Latham) 1801—south Queensland and New South Wales; *assimilis* Gould 1841—south-western Australia; *pallida* De Vis 1884—Northern Territory and north Queensland; *victoriae* Mathews 1912—Victoria, South Australia and Tasmania; *subpallida* Mathews 1912—north-western Australia; *howei* Mathews 1913—Victoria (mallee); *barcoo* White 1917—central Australia. In his recent work on the birds of South Australia Condon (1951) has synonymized *victoriae* and accepted *assimilis* and *barcoo*. Eyre Peninsula birds are included in the south-western race but the Victorian mallee birds are grouped with *leucophaea*.

The most satisfactory arrangement for *M. leucophaea* would appear to be as follows:

Microeca leucophaea leucophaea (Latham) 1801: South-eastern Australia (coastal) from Adelaide to central Queensland. Synonym: *victoriae*.

M. leucophaea barcoo White 1917: Drier areas of southern Australia from Cooper's Creek to western New South Wales.

M. leucophaea assimilis Gould 1840: South-western Australia, Eyre Peninsula and Victorian mallee. Synonym: *howei*. This form could be secondarily connected with *leucophaea* in south-eastern South Australia (and possibly Victoria).

M. leucophaea pallida De Vis 1884: Northern Australia. Synonym: *subpallida*. This name applies to the small birds of the north, the tails of which show a large amount of white. The birds of north-eastern Queensland (*vide* Cairns) are a problem since, unlike the

Gulf, Northern Territory and Kimberley birds, they are not pale but resemble the south-eastern stock in degree of pigmentation. The best course would appear to be not to grant them a special name but include them in *pallida* along with the other northern birds.

M. leucophaea zimmeri Mayr and Rand 1935: Port Moresby region of New Guinea.

Isolation and Speciation: The south-western stock, though it does extend into the drier areas, is isolated to-day (Serventy and Whittell 1948). Its similarity to the Eyre Peninsula and Victorian mallee stock indicates a common origin of the three. The eastern mallee stock is unlike that inhabiting the adjacent coast and western New South Wales hence, like the mallee populations of *Psophodes nigrogularis*, *Podargus* and others, it would appear to have derived from the west.

The similarity of the nominate race over large areas of the east and *pallida* along the north coast suggests that there is no isolation. It is more than likely, however, that some populations of *barcoo* are virtually cut off. In any event one population of *Microeca leucophaea*, the New Guinea form *zimmeri*, is certainly isolated, has differentiated, and could be said to be on the way to developing into a new species.

Microeca flavigaster Gould 1843 (Lemon-breasted Flycatcher)

This species ranges along the northern coastline of the continent from south of Bowen in the east to about the Daly River in the west. The habitat is said to be "savannah woodland and forest country" on Cape York (Thomson 1935), "open forest" at Mackay (Harvey and Harvey, in Mathews 1919-20, 8: 76) and "more numerous in the mangroves than elsewhere" on Melville Island (Rogers, in Mathews 1919-20, 8: 76). At Port Keats the writer found them mostly in the damper savannahs.

Specimens: Bowen (3); Inkerman (3); Cardwell, Rockingham Bay, Herbert River, Cairns, etc. (series); Cape York (series); Melville Island (6); Daly River and Port Keats (4).

Geographic Variation: Australian populations fall into two series, a north-western one (*flavigaster* Gould 1843) and an eastern one (*terraereginae* Mathews 1912), as Mack (1953) has noted. The former differs in having a clear white throat (instead of a drab one tinged with olive) and in the clearer, brighter, yellow breast.

M. flavigaster is, however, a plastic species as will be seen from differences in series from along the Queensland coast. In specimens from Cape York the throat feathers have a distinct yellowish suffusion so that the throat is like the breast or only slightly paler. The top of the head and back are uniformly deep olive. Only some Barron River birds (including the type of *terraereginae* are as bright as this; in the others the throat is greyer (less yellow). This is presumably the type named '*laetissima*' by Rothschild in 1916. A female and two unsexed birds from Inkerman are drab ventrally ("fawn yellow") whilst three from Bowen are similar but with some increase in the ventral colouring (increase in olive-yellow component).

Within the north-western form the series from Melville Island inclines towards the Cairns type, that is, there is a suggestion of olive through the throat. Mathews named these birds *melvillensis* in 1912, stating that they are a lighter yellow below and less green on the back. His type, however, is a very worn bird.

Wing-length measurements (mm) of adult males from various parts of the Australian range are as follows: Cairns area (8), 74–79 with one 83 (77); Cape York (6) 73–77 (76); Port Keats-Daly River (2), 73 and 76; Melville Island (4), 73-78 (75). There would not appear to be any difference in bill-length as between eastern and western populations, each falling within the general range of 8.1–8.8 mm.

Nomenclature: The coloration in this species is influenced somewhat by climate and the most satisfactory course is to recognise only a north-western and a north-eastern race, as follows:

Microeca flavigaster flavigaster Gould 1843. Synonym: *melvillensis*. Coastal Northern Territory from Port Keats to Melville Island (? and further east).

M. flavigaster terraereginae Mathews 1912. Synonym: *laetissima*. Cape York to Bowen, Queensland.

Microeca brunneicauda Campbell 1902 (Brown-tailed Flycatcher)

This species is stated to occur along the north coast from Point Torment to Darwin. The habitat is mangroves.

Vaurie (1953) has discussed the status of this somewhat puzzling species and points out its close relationships with *M. flavigaster*. On the basis of a supposed area of overlap in the Northern Territory, *M. brunneicauda* has been retained as a good species. Presumably *M. brunneicauda* originated in the Kimberleys.

Specimens: Point Torment (series) and Napier Broome Bay (2).

Geographic Variation: Mathews has separated the Kimberley stock racially (*tormenti* 1916) from the Darwin bird as "lacking the buff on the throat and having the inner web of the three outer tail feathers with a large whitish spot." I have been unable to locate any Northern Territory specimens of *M. brunneicauda* and until these are available not only can geographic variation not be discussed but the status of *M. brunneicauda* itself must remain suspect.

Wing-length measurements (mm) for adult males of *M. brunneicauda* from Point Torment are: 73-77 (mean of five, 75). The bills range from 9.6 to 9.8 mm.

Nomenclature: *Microeca brunneicauda brunneicauda* Campbell 1902: Darwin area of Northern Territory.

? ? *M. brunneicauda tormenti* Mathews 1916: Requires investigation.

Microeca griseoceps De Vis 1894 (Yellow Flycatcher)

I have not seen Australian material of this species but Mack (1953) lists a specimen from Claudie River, Cape York, in the H. L. White Collection and one from Tozer Gap nearby in the Queensland Museum Collection. The habitat of Mathews' '*Kempiella kempi*' is said to be "edge of rain forest".

Mack was unable to distinguish Australian birds from the nominate *M. griseoceps griseoceps* of southern New Guinea. It is probably quite a recent immigrant to Australia.

Petroica multicolor (Gmelin) 1789 (Scarlet Robin)

In Australia this species extends through the sclerophyll forests of the east from south Queensland to Kangaroo Island. There are isolated stocks in the south-west corner of the continent and in Tasmania. *P. multicolor* occurs as a complex of forms in the Pacific (Mayr 1934). Similar examples of island speciation in the genus *Petroica*, this time in New Zealand and the subAntarctic islands, are demonstrated by Fleming 1950.

Specimens: Emu Vale, south Queensland (2); Blue Mountains, mainly Lithgow area (large series); Melbourne area (series); Flinders Island (2); Tasmania (series); coastal South Australia (series); Kangaroo Island (2); south-western Australia (series). Included in these were the types of Mathews' '*samueli*' and '*frontalis*'.

Geographic Variation: Only in the females can any geographic colour variation be seen. Those from the south-west have darker (sooty) throats, and are darker dorsally than those from the east; it is only the odd bird that could be confused with them. Tasmanian females may tend to have 'browner' throats than those from the mainland but the difference is not significant.

As has been noted by Condon (1951) the 'characters' in males that have been used in the separating of races (size of white cap, amount of white on the outer tail feathers, intensity of scarlet on the breast) are of no significance. The males certainly do not vary geographically in colour.

Wing-length measurements (mm) of adult males from various parts of the geographic range are as follows: Emu Vale, Queensland (2), both 73; Blue Mountains, New South Wales (26), 75-80 (77); Dandenongs (5), 73-78 (75); Tasmania (9), 75-78 (76); Kangaroo Island (2), 78 and 76; south-eastern South Australia (4), 75-78 (77); south-western Australia (7), 73-77 (75).

It is obvious from the above that *Petroica multicolor* does not vary in size geographically.

The study of variation shows that the south-western isolate of *P. multicolor* has started to differentiate but the Tasmanian one has not.

Nomenclature: The following names should be reduced to synonymy of *boodang*: *leggii* Sharpe 1879 (Tasmania); *halmaturina* Campbell 1906 (Kangaroo Island); *frontalis* Mathews 1912 (Parwan, Victoria). This leaves the races:

Petroica multicolor boodang (Lesson) 1837: Eastern Australia and Tasmania.

P. multicolor campbelli Sharpe 1898: South-western Australia.

Petroica goodenovii (Vigors and Horsfield) 1827 (Red-capped Robin)

This species extends through the savannah and mulga areas of the continent. It avoids the sclerophyll and rain forest areas, which are occupied by the related species *P. multicolor*, *P. phoenicea*, and *P. rosea*.

In addition to the birds listed below two worn adult males from Alexandria were seen.

Geographical Variation: With the exception of slight paling in females from the drier areas there is no geographical colour variation in this species.

Wing-length measurements (mm) of adult males from various parts of the range of *Petroica goodenovii* are as follows: south-western Australia—Broome Hill (5), 64-67 (65); South Australia—Lyndhurst, Eyre's Peninsula (7), 62-66 (64); Victorian mallee (4), 63-64 (64); eastern New South Wales—Nepean River, Tarana, Bathurst (7), 64-67 (65); western New South Wales—Narromine, Lachlan River, Buckinguy (8), 64-66 (65); Cooper's Creek-Birdsville (2), 63 and 64; central Australia—Macdonnells and Ayer's Rock (7), 61-66 (64); Carnarvon (3), 63-64 (64); Mungi in Kimberleys (3), 61-67 (64); Darwin (1), 62; 'north Queensland' (3), 63-64 (64).

It is apparent that there is no size variation in *Petroica goodenovii*.

Nomenclature: Mathews has created a number of races on such characters as "large size", "brighter coloration above and more extensive below", "deeper red coloration on the forehead and breast", "longer bill", "paler coloration". None of these are, however, justified. Accordingly, the following names fall into synonymy: *ramsayi* Sharpe 1879; *quoyi* Mathews 1912; *ruficapilla* Mathews 1912; *alexandrae* Mathews 1912.

Petroica goodenovii is not divisible into races.

Petroica phoenicea Gould 1837 (Flame Robin)

Range: *P. phoenicea* extends through the coastal sclerophyll forests of eastern Australia from northern New South Wales (most northerly specimen is from Clarence River) to the Dandenongs, Adelaide, Bass Strait Islands, and Tasmania. It is an inhabitant of the highlands in the more northern parts of its range.

P. phoenicea is a winter migrant to South Australia, arriving in April and departing in July-August (Terrill and Rix 1950). These birds presumably come from Tasmania. The species sparingly visits the lowlands about Sydney in winter but whether these individuals are from the adjoining highlands (the generally-accepted theory) or the south is not known. It might be noted that Campbell (1909) considers that there is no migration between Tasmania and the mainland in *P. phoenicea*.

Specimens: Clarence River (2); Dungog (1); Blue Mountains-Cox's River and Lithgow (large series); Buckingbah (3); Murray River (1); Marrangaroo (2); Dandenongs (series); King Island (3); Cape Barren Island (2); Tasmania—Arve River, Railton, Launceston (series); Adelaide (series).

Geographic Variation: There is no geographic colour variation in this species, either in the males or in the females.

Wing-length measurements (mm) for adult males from various parts of the range are as follows: Clarence River (2), each 80; Blue Mountains (32), 78-83 (81); Melbourne (5), 80-83 (81); Adelaide (3), 81-82 (81); Tasmania (15), 79-81 (80). Most of the New South Wales specimens were collected during the autumn and winter, hence, theoretically, might be migrants from the south. Wing-lengths of a November male (79 mm) and three taken in August (79, 80, 83), plus similarity of the means of the northern and southern series demonstrate, however, that there is no geographic size variation in *P. phoenicea.*

Nomenclature: Variation in the amount of white on the forehead, introduced by Mathews as a race character, is of no geographic significance. There are no races in *P. phoenicea.*

Synonyms: *addenda* Mathews 1912; *albicans* Mathews 1912; *tasmanica* Mathews 1922.

Petroica rosea Gould 1839. (Rose Robin)

P. rosea ranges through the rain forests of the east coast from north of the Bunya Mountains to west of Melbourne.

Specimens: These have been seen from the Bunya Mountains, Tweed River, Sydney and Melbourne areas.

Geographic Variation: There is no geographic variation in colour.

Wing-length measurements (mm) for adult males from various parts of the range are as follows: Bunya Mountains (2), 63, 66; Tweed River (2), 65, 66; Sydney (12), 63-69 (66); Dandenongs (3), 67-68 (68). No geographic variation in size is indicated.

Nomenclature: Mathews has described a race (*queenslandica* 1916) from 'North Queensland' as paler than the nominate form. The type specimen of this form is not in the American Museum of Natural History and hence I am unable to report on it. As far as can be determined, however, *P. rosea* does not extend to north Queensland. Various lists (*e.g.*, Bourke and Austin 1947; White 1946) do not include it, nor have more recent observers (*vide* N. Chaffer, pers. com.) seen it.

In view of the general homogeneity of *P. rosea* it would appear best to drop '*queenslandica.*'

Petroica rodinogaster (Drapiez) 1819. (Pink Robin)

This is the Tasmanian breeding representative of *P. rosea* and is no more than a well-differentiated race of that form. A substantial number of these birds winter in Victoria. Some Victorians believe that *P. rodinogaster* occasionally breeds in that State (R. P. Cooper, pers. com.). Demonstration of this (no hybrids between *P. rosea* and *P. rodinogaster* are known) would, of course, indicate specific distinctness. I leave *rodinogaster* as a species until this matter is clarified.

Specimens: Tasmania (series); southern Victoria—winter migrants, collected April-June (series).

Geographic Variation: *P. rodinogaster* differs from the mainland *rosea* in its pale pink (instead of rose pink) ventral surface, and in the extension of the coloration right over the under-surface instead of being restricted to the breast and upper abdomen. Also, the back and throat are sooty-black in *rodinogaster*, not deep grey.

There is no difference in colour between Tasmanian birds, those from King Island, and winter individuals from Victoria.

Wing-length measurements for adult males (mm) are as follows:

Tasmania (12), 64-71 (68); Dandenongs (4), 65-70 (68).

Nomenclature: Mathews states that Victorian birds are "smaller and darker above" than those from Tasmania. His type of '*inexpectata*' 1912, is, however, an unusually small bird (wing-length of 65 mm, as against 68-71 in Tasmania) and hence exceptional. The colour difference stated does not hold.

Petroica cucullata (Latham) 1801. (Hooded Robin)

This sedentary robin ranges throughout the dry savannah and mulga areas of the interior of the continent, avoiding the more heavily timbered eastern and south-western zones. The range is apparently continuous around the periphery of the continent.

Specimens: Melbourne area (series); eastern New South Wales—Mulgoa and Blue Mountains (series); Kempsey (2); Adelaide area (5); Port Lincoln (2); Ooldea (1); western New South Wales—Moolah (4); Ayer's Rock (2); Macdonnell Ranges (5); Charleville and Cloncurry (2 each); Normanton (3); McArthur River (1); Alexandria (4); Goyder River (1); south-western corner (series); East Murchison (3); Dirk Hartog Island (2); Hamersley region (4); Derby (3); Mungi (1); Marngle Creek (5); Napier Broome Bay (2); coastal Northern Territory—Mary and Alligator Rivers, Glencoe (series); Melville Island (5).

Geographic Variation: The only geographic colour variation to be seen in *P. cucullata* is that the males from the north-west tend to have a little more white on the tail and the females would appear to be a little lighter on the dorsal surface than those from elsewhere.

The northern populations of *P. cucullata* are distinctly smaller than southern ones, the changeover apparently being clinal. Wing-length measurements (mm) of adult males are as follows:

East:—Melbourne Area (5), 98-101 (99); Sydney Area (10), 96-103 (99); Western New South Wales (2), each 99; Charleville (1), 92; Cloncurry (1), 93; Normanton (2), 90, 92; McArthur River (1), 91;

Central:—Adelaide Area (4), 94-100 (98); Port Lincoln (1), 96; Ooldea (1), 93; Ayer's Rock (1), 97; Macdonnell Ranges (3), 93-95 (94); Alexandria (2), 92, 95; Goyder River (1), 87.

Western:—South-west corner (8), 92-97 (95); East Murchison (3), 93-97 (94); Dirk Hartog Island (2), 95, 94; Hamersley region (1), 92; Derby (2), 88, 89; Mungi (1), 93; Marngle Creek (4), 89-94 (91); Napier Broome Bay (1), 94; Coastal Northern Territory (6), 87-94 (91); Melville Island (3), 86-90 (88).

Nomenclature: Names have been given to populations of *P. cucullata* as follows: *vigorsi* (Mathews) 1912 ("smaller wing"), *westralensis* (Mathews) 1912 ("again smaller . . . . . and with less white on the greater wing-coverts and outer edge of the secondaries"); *picata* Gould 1865 ("much smaller" than *cucullata*); *melvillensis* (Zietz) 1914 ("smaller than *subpicata*"); *subpicata* (Mathews) 1912 ("larger than *picata* and duller than *cucullata*"). It is clear that most of these 'races' merely represent scattered samples from different parts of the transition area from southern to northern type. There is no point in recognising other than:—

Petroica cucullata cucullata (Latham) 1801: Southern Australia.

Synonyms: *vigorsi, westralensis.*

P. cucullata picata (Gould) 1865: Northern Australia.

Synonyms: *subpicata, melvillensis.*

Petroica vittata (Quoy and Gaimard) 1830. (Dusky Robin)

This species, one of the more distinctive endemics of Tasmania, is an inhabitant of the scrubs and forests of the main island and Flinders and King Islands in Bass Strait.

Specimens: Large series from Tasmania, many specimens without precise locality; two skins from Flinders Island.

Geographic Variations: With the possible exception of the King Island population, which I have not seen, this species does not vary geographically. Flinders Island birds, stated by Mellor and White to be "much darker throughout" do not differ consistently in this way. Cape Barren Island, from which Mathews has described his race '*bassi*' (1914), lies close to Flinders Island which is included by him in the range of this form. The name can be reduced to synonymy. The King Island form ('*kingi*' 1914), described by Mathews as having a "buff breast instead of a grey one", could be distinct as the populations of several species are differentiated on this island. I have not, however, seen any material.

Measurements (mm) of adult male *P. vittata* from the mainland of Tasmania are as follows: Bill-length 11.4.12.7 (mean of 9, 11.7); wing-length, 86-93 (89); tail-length, 60-67 (62).

Nomenclature: *Petroica vittata vittata* (Quoy and Gaimard), 1830: Tasmania, Flinders, and Cape Barren Islands.

P. vittata kingi (Mathews) 1914: King Island (subject to confirmation).

Eopsaltria australis (White) 1790. (Yellow Robin).

(Figure 6.)

This species is basically an inhabitant of the coastal sclerophyll and rain forests. It extends from Cooktown (Mack 1953) to Millicent (Terrill and Rix 1951) in the east. In the western section there is an isolated population on Eyre Peninsula and another one ranging from the Murchison to Norseman (Serventy and Whittell 1948).

Inland range limits in the east correspond to 'outlyers' of forest and are now known fairly precisely. They are: Atherton Tablelands, Duaringa (Barnard and Barnard 1925), Carnarvon Range (skins), Toowoomba (E. Langton, pers. com.), Murphy's Creek (E. A. R. Lord, pers. com.), Moonie River near Mungindi (Elliott 1938), Moree (Sullivan 1931), Gilgandra (P. A. Bourke, pers. com.), Nyngan (A. R. McGill, pers. com.), Manilla and Cobborah (skins), Leeton (skins), Inglewood north of Bendigo (Favaloro 1953). Hence, though the main habitat of *E. australis* is in the better watered regions, in places it extends well out into the inland savannahs (on Eyre Peninsula into the 15-inch rainfall zone).

From the distributional point of view the absence of *E. australis* from the Mount Lofty ranges in South Australia (Ninety Mile Desert being a distributional barrier) and its occurrence on the eastern side of the Nullarbor Plain (that it must have crossed in former times) will be noted.

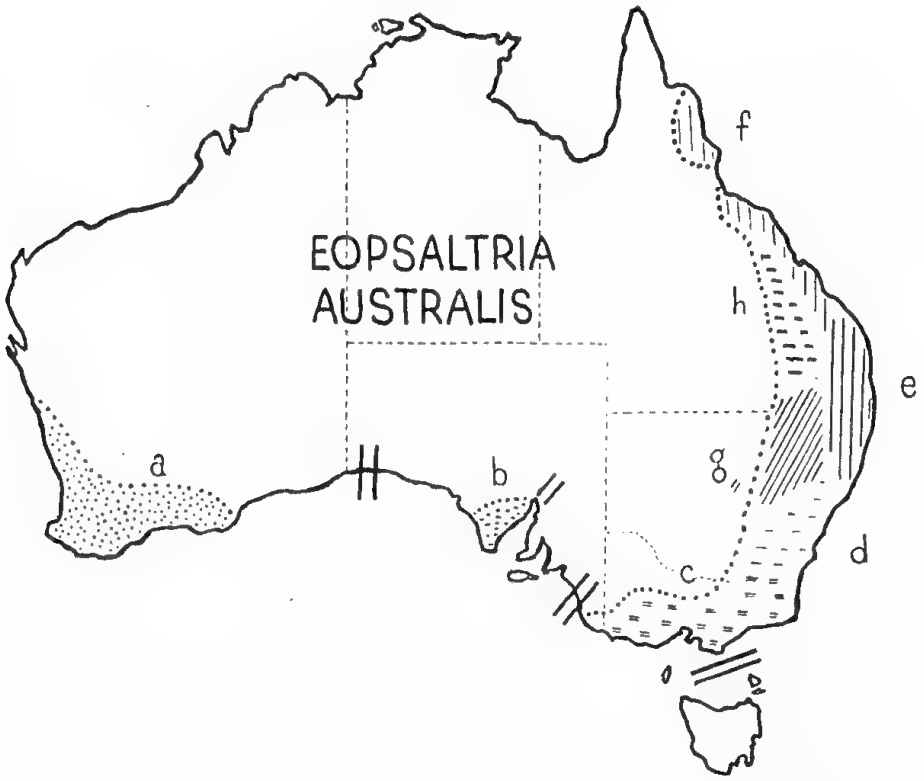


Fig. 6.—Isolation and variation in the Yellow Robin (*Eopsaltria australis*). The grey-breasted type obviously arose in the south-west of the continent and has secondarily recrossed the Nullarbor Plain to leave an isolate on Eyre Peninsula (b). Parallel lines indicate distributional barriers. a. *griseogularis*. b. *rosinae*. c. *viridior*. d. *australis*. e. *chrysorrhoa*. f. *magnirostris*. g. *austina*. h. *coomooboolaroo*.

Range limits are of necessity approximate. Distribution inland is discontinuous and 'spotty'.

Specimens: South-west corner of continent (series); Eyre Peninsula (5); south-eastern South Australia (4); Glenelg River (2); various localities in Victoria, mostly near Melbourne—Bayswater, Selby, Rosedale, Port Fairey, Mount Macedon, Black Spur (series); Yanco (2); Berrima (1); Narooma (1); Ulladulla (1); Lithgow (series); Sydney area (series); Cobborah (2); Dorrigo (series); Bellingen River, Nymboida, Port Macquarie, Armidale, Manilla (1 each); Richmond River (series); Tenterfield (1); Macpherson Range (2); Moreton Bay, Brisbane River and Stradbroke Island (series); Bunya Mountains (series); Gympie (2); Blackall Range (2); Mary River (1); Carnarvon Ranges (3); Duaringa area (3); Proserpine (1); Mackay (1); Bowen (2); Cardwell (3); Cairns area (series).

Geographic Variation: This species falls into three main colour types: Grey-breasted western birds (*griseogularis*), yellow-breasted south-eastern birds with olive-green rump (*australis*), and central- and north-eastern yellow-rumped birds (*chrysorrhoa*). Much controversy has surrounded the status of the last two forms.

The following races may be recognised in *E. australis*:

(*a*) Murchison to Norseman, south-western Australia; (*griseogularis* Gould 1838). The breast is grey, the abdomen yellow.

(*b*) Eyre Peninsula to Lake Dundas, South Australia: (*rosinae* (Mathews) 1912). Like *griseogularis* but the rump is olive-green instead of yellowish-olive as Condon (1951) has remarked.

(*c*) Millicent, south-eastern South Australia, to Victoria: (*viridior* (Mathews) 1912). These are greener on the dorsal and ventral surfaces than *australis* from Sydney.

Three specimens in the South Australian Museum Collection labelled 'Mildura' (coll. Cockerell) are most interesting. They have bright yellowish-olive rumps and the olive tones are much reduced dorsally. However, the species does not occur near Mildura (N. J. Favaloro, pers. com.), hence their origin is something of a mystery. They could represent an undescribed race.

(*d*) South- and central-eastern New South Wales (Yanco, Narooma, Ulladulla, Berrima, Lithgow, Sydney, Newcastle). This is *australis* (White) 1790.

(*e*) Northern New South Wales to central Queensland, coastal section east of Great Dividing Range: (*chrysorrhoa* Gould 1869).

This form is characterized by a bright yellow rump that renders it most conspicuous in the field. The breast is also brighter. Typical specimens have been seen from: Dorrigo, Port Macquarie, Bellingen, Richmond River, Armidale, Tenterfield, Macpherson Range, Moreton Bay, Stradbroke Island, Bunya Mountains, Blackall Range, Proserpine, Mackay, Bowen. The occurrence of 'duller' birds that approach the colouring of the brighter *australis* from Sydney will be noted in places. This applies to a couple of the Dorrigo series, a Nymboida bird, and one or two in the south-eastern corner of Queensland (*vide* a male from Pine Mountain in the Australian Museum). Such birds undoubtedly account for field records of '*E. australis*' in north-eastern New South Wales and southern Queensland (see discussion later).

(*f*) North-eastern Queensland (Atherton, Cairns, and Cooktown): (*magnirostris* Gould 1869). The colouring is like that of *chrysorrhoa* but bills and wings average slightly larger. I consider this a poorly-defined form. (See also remarks of North 1903).

(*g*) Central and northern New South Wales (inland): This is Mathews' *austina* 1915, described as differing from *australis* "in having the head and back grey, the latter altogether lacking the greenish tinge; the under-surface very much paler". The population actually also has a pale yellow rump, as was intimated by Mathews when he subsequently placed it in the synonymy of *chrysorrhoa*. Typical birds are from Cobborah and specimens from Tamworth and Manilla fit quite well.

(*h*) South-central Queensland inland—Carnarvon Range and Duaringa (inland from Rockhampton): This is *E. australis coomooboolaroo* Campbell 1913. It resembles the dry-country birds to the south in reduction of olive tones dorsally. The rump, however, approaches that of typical Sydney coastal birds. Campbell describes it as "wax yellow". I would call it "yellowish olive". Specimens in the Los Angeles County Museum from the Carnarvon Range (200 miles from the sea) are grey above and have an olive-green rump (two males and one female). Actually *coomooboolaroo* is not smaller than *chrysorrhoa*, as stated by Campbell. Its coloration obviously reflects the environment (dry scrub) in which it lives, although possibly some isolation is involved.

Size Variation: Wing-length measurements of adult males (mm) of *E. australis* from various parts of the range are as follows: South-western Australia (8), 84-90 (87); Eyre Peninsula (2) 90 and 95 (92); Glenelg River (1), 87; Melbourne area (6), 86-92 (87); Yanco (1), 86; Sydney (14) 86-91 (88); Lithgow (3), 88-92 (90); Dorrigo (5), 85-94 (90); Manilla (1), 91; Richmond River (4) 89-94 and one 97 (93); Bunya Mountains (5), 89-93 and one 96 (92); Carnarvon Range (2), 90 and 94; Coomooboolaroo (1), 91; Mackay (1), 89; Bowen (1), 91; Cairns (11), 88-93 and one 96 (91).

Wing-length measurements (mm) of adult females are as follows: South-western Australia, 83 and 85; Eyre Peninsula (3), 81-88 (84); Melbourne area (2), 78 and 82; Sydney area (6), 80-90 (84); Lithgow (3), 79-83 (81); Dorrigo (2), 82 and 87; Bunya Mountains (3), 82-87 (84); Coomooboolaroo (1), 83; Bowen (1), 80; Cairns (6), 82-87 (85).

Bill-length measurements have been made independently by the writer on specimens in the Australian Museum (measuring from the end of feathering to the tip) and by Dr. Ernst Mayr on the collection in the American Museum of Natural History (from depression at the base of the skull to the tip).

Bill (Males)

Writer's measurements (mm): South-western Australia (7), 10.5-12.0 (11.3); Port Lincoln (2), 12.2 and 12.4; Sydney (9), 11.0-12.0 (11.5); Dorrigo (5), 11.0-11.8 and one 12.5 (11.6); Manilla (1), 11.7; Cairns (6), 11.4-12.4 but one 10.9 (really a male?) and one from Kuranda 12.8 (12.0).

Dr. Mayr's measurements (mm): Sydney (6), 17.1-17.9 and one 18.7 (17.6); Lithgow (5), 17.8-18.3 and one 18.9 (18.2); Coomooboolaroo near Duaringa (1), 19.0; Mackay (1), (2), 17.4 and 18.9; Richmond River (3) 17.3, 18.9, and 20.6 respectively; Bunya Mountains 19.1; Bowen (1), 18.4; Cairns (7), 17.9-18.9 and one 19.5 (18.6).

Bill (Females)

The writer's measurements (mm): Sydney (6), 10.6-11.8 (11.0); Dorrigo (2), 11.4 and 11.5; Cairns (1) 10.7. Mayr's measurements: Lithgow (3) 14.9-16.3 (15.4) Sydney—two sub-adult, 17.0 and 17.1; Bunya Mountains (3), 15.8, 16.3, 17.1 (16.4); Coomooboolaroo (1), 15.9; Bowen (1), 16.0; Cairns (6), 15.5-16.5 (16.0).

The measurements indicate that in *Eopsaltria australis*, in contrast with most bird species, the northern populations are slightly larger than the southern ones (using wing-length as the criterion of over-all size). Bill-length measurements indicate that, although the north Queensland birds do tend to average larger in this character than those from further south, odd birds with large bills do occur in northern New South Wales. The status of the form *magnirostris* is accordingly doubtful.

Variation in E. australis *and the Environment*

(*a*) *Yellow rump in eastern Australia.*—Following reports that the olive-rumped and yellow-rumped 'species' of *Eopsaltria* coexisted in northern New South Wales and that the former occupied open forest and the latter rain forest, the writer circularized various field ornithologists during 1942-1943. There proved to be disagreement on the question. It was the opinion of L. J. Rhodes (letter of 14 March 1943) that, over a wide area of the north-east, one occurred in one habitat and the other in the second. H. E. Brenton (letter of 18 February 1943) and F. M. Irby (5 November 1942) agreed but stated that the two coexisted in the same forests. A. J. Elliott and M. Goddard, however, maintained that the two colour-types were nothing more than extremes of the same bird. Subsequently a fine series of specimens, forwarded by M. Goddard to the Australian Museum, amounted to proof positive that there was complete intergrading in the Dorrigo area.

Once adequate taxonomic material was assembled it was apparent that the Elliott-Goddard view was, in fact the correct one, there being intermediate individuals from other areas also, *vide* south Queensland. It was apparent, moreover, that northwards from Dorrigo the 'olive-rumped' birds amounted to no more than odd individuals in any population (see previously).

Subsequently, the writer sought to check the supposed link between forest type and rump-colour in the field. No such pattern presented itself. The field trip did, however, confirm the complete dominance of the yellow-rumped bird to the north of Port Macquarie

where, apart from rain forests, the sclerophylls proved to be of a denser, wetter, type than those further south. Inland in the north in the Armidale region, where forests did tend to be somewhat dry, the birds, though paler, nevertheless had yellow rumps, suggesting the influence of stock from the rain forests to the east.

The distribution of yellow-rumped robins corresponds fairly well with the southern limits of extensive tracts of tropical rain forest. It would seem that since they do not occur far south of Dorrigo and are replaced by olive-rumped birds under savannah conditions in central Queensland, that the character is in some way related to the warmer jungle habitat. *Eopsaltria* has the habit of clinging vertically to the sides of trees, in which position the coloured breast is obscured but the rump is visible. A bright rump would certainly render the owner conspicuous under open forest conditions. In jungle, however, camouflage is unnecessary and the coloured rump appears to fulfil the function of a recognition marking. In a letter to me, A. H. Chisholm has described the yellow rump as glowing like a piece of luminescent fungus in the dark jungle. As it is difficult to conceive of a past distributional barrier between *chrysorrhoa* and *australis* it would appear that the case is one of the environment controlling the development and maintenance of a character.

(*b*) *Grey breast in Western Australia.*—It is possible that this represents an expression of a need for more effective camouflage in this section for, next to the rump, the breast is the most conspicuous part of the bird. These populations are, however, isolated so that other factors may well be involved.

(*c*) *Loss of olive colouring and general drabness in dry areas.*—These trends seen in the inland populations, are simply expression of the Gloger Effect.

(*d*) *Size differences between southern and northern populations.*—Northern populations of *E. australis* would appear to average slightly larger than southern ones. The reason however, is obscure.

Nomenclature: *Eopsaltria australis griseogularis* Gould 1838: South-western Australia. *E. australis rosinae* (Mathews) 1912: Eyre Peninsula to Lake Dundas. *E. australis viridior* (Mathews) 1912: South-eastern South Australia to Victoria. *E. australis australis* (White) 1790: South and central eastern New South Wales. *E. australis chrysorrhoa* Gould 1869: Coastal northern New South Wales to central Queensland. *E. australis magnirostris* Gould 1869: Coastal north Queensland. *E. australis austina* Mathews 1915: Central and northern New South Wales (inland). *E. australis coomooboolaroo* Campbell 1913: Central Queensland (inland).

Mathews' races '*wongani*' and '*quoyi*' 1920 are synonyms of *griseogularis*.

Eopsaltria georgiana (Quoy and Gaimard) 1830 (White-breasted Robin)

This species is confined to the south-west corner of the continent, being most plentiful from Cape Naturaliste to Albany but occurring in gullies in the Darling Range north to above the level of Pinjarra (Serventy and Whittell 1948). It inhabits dense thickets fringing brooks and swampy areas.

E. georgiana is particularly interesting in that it is one of the only two birds species restricted to the south-west corner of the continent. Its origin is obscure.

Specimens: Series from King George's Sound, Wilson's Inlet, and Warren River.

Geographic Variation: This species does not vary geographically and I agree with Mathews in reducing his '*warreni*' 1916 to synonymy. Twelve males vary in wing-length from 74-82 mm (mean, 78). Bills vary from 10.9-11.7 mm (11.4).

Peneoenanthe pulverulenta (Bonaparte) 1851 (Mangrove Robin)

This species ranges along the northern coastline of the continent from Exmouth Gulf in the west to Cardwell in the east. The habitat is mangroves.

Specimens: Hampton Harbour, mid-west Australia 1—the type of *cinereiceps* Hartert); Derby (5); Napier Broome Bay (2); Alligator River (2); Melville Island (5); Normanton (3); Cape York (4); Rockingham Bay (2).

Geographic Variation: This is mainly in the dorsal coloration. The specimen from the 'mid-west', those from Derby and the two females from Napier Broome Bay, are distinctly paler (lighter grey) above than the typical. Melville Island and Alligator River birds are a stage darker towards the Cape York-east Queensland type. Birds from the intermediate dry area at Normanton are relatively pale above. The Normanton birds lack the greyish breast marking but so do many of the Melville Island birds.

Wing-length measurements of adult males (mm) are as follows: mid-western Australia (1), 87; Derby (3), 81-84 (83); Melville Island (3), 83-88 (85); Normanton (3), 82-85 (84); Cape York (4), 82-88 (86); Rockingham Bay (1), 87. No geographic size variation is indicated by these small series. Bill length (13.4-14.0 mm) does not vary geographically.

Nomenclature: Mathews described several races in *P. pulverulenta* on such characters as size, dorsal coloration, colour of head and lores. Subsequently Mathews reduced his Norman River, Napier Broome Bay, and Melville Island races to synonymy, leaving three as follows: *leucurus* (Gould) 1869—Cape York; *cinereiceps* Hartert 1905—mid-western Australia; *alligator* (Mathews) 1912—Northern Territory.

The best procedure, nomenclatorially, would appear to be to follow Mathews subdivision, but to include birds from the southern Kimberleys with *cinereiceps*, group the Northern Territory birds and the paler individuals from Normanton under *alligator*, and include the birds from eastern Queensland under the Cape York *leucurus*. Though *P. pulverulenta*, like all mangrove species, is undoubtedly "broken up" distributionally the nature of its geographic variation suggests Gloger influences to be operative and that variation is largely clinal.

Peneoenanthe pulverulenta leucura (Gould) 1869: Cape York and eastern Queensland.

P. pulverulenta alligator (Mathews) 1912: Gulf of Carpentaria to coastal Northern Territory.

P. pulverulenta cinereiceps (Hartert) 1905: Mid-western Australia to Kimberleys.

Under this arrangement *normani* and *greda* become synonyms of *alligator* and *connectens* of *cincereiceps*.

Heteromyias cinereifrons (Ramsay) 1875 (Grey-headed Robin)

This robin is confined to the rain forests of the Atherton area of north-eastern Queensland. It is a close relative of *H. albispecularis* of New Guinea from which it has just about reached that stage of differentiation entitling it to be called a species. The genus is absent from the intervening rain forests on Cape York so that the two stocks are isolated by 500 miles.

Specimens: Ten from the general Atherton-Cardwell area.

Geographic Variation: As would be expected from its restricted range there is no evidence of geographic variation in this species. Mathews' race '*athertoni*' was subsequently reduced to synonymy by its author.

Males vary in wing-length from 104-113 mm (mean of 7, 109). The bill ranges from 14.2-14.9 mm.

Poecilodryas superciliosa (Gould) 1847 (White-browed Robin)

This species extends along the northern coastline of the continent from about Derby in the north-west to Inkerman and the Burdekin Lakes in eastern Queensland. In the Derby area Rogers refers to the species occurring in the thick growth along river banks, whilst Elsey states that on the Victoria River it feeds on the ground and makes for pandanus thickets when disturbed (in Mathews, 1919-20; 8: 193). On Cape York the species is described (by Macgillivray) 1919-20 in Mathews 8: 189) as occurring along the edges of the scrub. Thomson (1935) refers to them being numerous in scrub fringing the Coleman River and in small areas of scrub that exists as 'outlyers'. Gilbert (1919-20 in Mathews 8: 189) states that along the Burdekin *P. superciliosa* inhabits the dense, jungle-like vegetation growing beneath the shade of fig trees along the banks. It would appear from the above that *P. superciliosa* is essentially a monsoon forest form and does not occupy mangroves. This is important in explaining its breaking up into north-western and eastern forms.

Specimens: Fitzroy River (5); Parry's Creek (5); coastal Northern Territory—Alligator, Daly, and Margaret Rivers (4); McArthur River (1); Gregory River (5); Cape York (2); Cairns-Cardwell (5); Inkerman (1).

Geographic Variation: *P. superciliosa* falls into two distinctive types.

(*a*) Fitzroy River in the Kimberleys to Gregory River in the Gulf of Carpentaria (*cerviniventris* (Gould) 1857). In this form the flanks are a pronounced rufous, the back is brownish and the top of the head is dark.

(*b*) Cape York to Inkerman (*superciliosa*). This form lacks the reddish colouring altogether and the flanks are plain like the breast.

Wing-length measurements of adult males (mm) from various parts of the range are as follows: Derby (4), 85-91 (88); Parry's Creek (3), 87-90 (88); coastal Northern Territory (3), 86-92 (88); McArthur River (1), 88; Gregory River (4), 83-91 (86); Cairns-Cardwell (3), all 82; Inkerman (1), 78. Eastern birds would appear to be smaller than those from the north-west and Northern Territory but more material would be necessary to prove this.

Mathews has described several additional forms in *P. superciliosa*. Cape York birds are said to be darker and smaller than those from further south in Queensland (*'yorki'* 1916). Kimberley birds are described as being different in having a grey band on the throat and the buff on the sides very much lighter (*'belcheri'* 1912). Derby birds are stated to have the fore-head brown instead of blackish and more white on the outer tail-feathers (*'derbyi'* 1913). The Gulf birds (*'gregori'* 1914) are said to have the band on the upper-breast much lighter, the belly and abdomen white, and the sides and flanks much less buff.

Nomenclature: I agree with Mack (1953) that only north-western and north-eastern forms should be allowed. Accordingly, *yorki* becomes a synonym of *superciliosa*, and *belcheri*, *derbyi*, and *gregori*, synonyms of *cerviniventris*.

Poecilodryas superciliosa superciliosa (Gould) 1847: Cape York to Inkerman.

P. superciliosa cerviniventris (Gould) 1857: Fitzroy River (Kimberleys) to Gregory River, Gulf of Carpentaria.

These forms are well-differentiated isolates approaching species status.

Tregellasia capito (Gould) 1954 (Pale Yellow Robin)

(Figure 7.)

This species ranges along the east coast of the continent from about the Williams River, New South Wales, to the Cedar Bay-Cooktown area. The habitat, rain forest, is broken up into a series of pockets.

Specimens: Series from northern New South Wales (Dorrigo, Bellingen River, Richmond and Tweed Rivers); single bird from Brisbane area; Cardwell and Cairns (series); Cedar Bay (3).

Geographic Variation: The species falls into two colour forms, differing in that the northern one (*nana* (Ramsay) 1878) has a rufous tint on the lores and round the eye, as noted in the author's original description. The distribution of these forms corresponds to the two main belts of rain forest (Fig. 6). There is no doubt that they are isolated from each other.

Wing-length measurements (mm) of adult males are as follows: Dorrigo (1), 84; Bellingen (4), 74-81 (79); Richmond River (3), 77-83 (8); Tweed River (1), 75; Brisbane (1), 82; Cardwell-Cairns (7), 72-77 (75); Cedar Bay (2), each 74. It is apparent that the northern form is the smaller. The northern form would appear to have the larger bill, as indicated by measurements (mm) of males: New South Wales (9), 8.8-9.4 with one at 9.8 (9.1); North Queensland (7), one 9.3 with others 9.7-10.0 (9.8).

Nomenclature: *Tregellasia capito capito* (Gould) 1854: New South Wales to the Rockhampton area of Queensland (Mack 1953).

T. capito nana (Ramsay) 1878: North Queensland from Cardwell to the Cooktown district. Mathews' *'barroni'* 1916 is a synonym if this form.

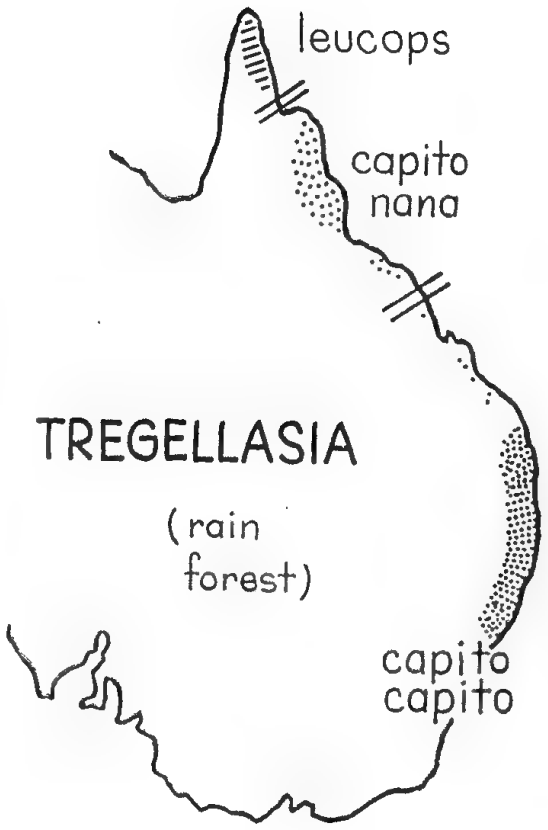


Fig. 7.—Distribution of forms in the rain-forest genus *Tregellasia* (large-headed robins). *T. capito* is broken up into a southern and a northern form by the extensive gap in its habitat in central Queensland. *T. leucops* is a New Guinea species that has established itself (like *Monarcha frater*, *Microeca griseoceps*, and others) in the rain-forests of northern Cape York.

Tregellasia leucops (Salvadori) 1876. (White-throated Robin)

(Figure 7.)

The Australian range of this New Guinea species extends southwards down eastern Cape York Peninsula to the Rocky Scrub district at the end of the northern rain forests (Mack 1953). It is the counterpart of *T. capito* in the Cape, inhabiting tropical rain forest.

Specimens: Odd birds from Piara (including type of Mathews' '*piara*' 1916), Claudie River, and 'Cape York', including type of Rothschild and Hartert's '*albigularis*' 1907).

Geographic Variation: The Australian populations are distinct from those of New Guinea (whole of throat white, etc.) and constitute a good isolate. As noted by Mathews, when he reduced '*piara*' to synonymy, and Mack (1953), *T. leucops* does not vary within Australia.

Three Australian males have wings measuring 77 (the type), 74, and 79 mm respectively. Two females, one of them the type of '*piara*', each have wings measuring 72 mm.

Tregellasia leucops albigularis (Rothschild and Hartert) 1907: Cape York (south to Rocky Scrub).

VARIATION AND SPECIATION

The various flycatchers differ widely in the extent and nature of their geographic variation. There are a number of well-differentiated isolated forms and others in which striking colour and size clines occur. At the other extreme several widely-ranging species do not vary at all geographically.

Speciation is occurring in a number of flycatcher genera. The number of morphologically differentiated isolates, forms that have the potential of developing into new species, is in the region of fifteen, or slightly less than one to every two species. This figure of course applies to the Australian continent only. These isolates are at different stages of differentiation. The most distinctive, the insular *Petroica rodinogaster*, has now demonstrated that it has reached species status by renewing contact with the parental *P. rosea* without interbreeding. Only slightly less distinct from their parental stocks are *Poecilodryas superciliosa cerviniventris* and *Eopsaltria australis griseogularis* and, at a somewhat lesser stage of differentiation, are *Rhipidura fuliginosa albicauda* of the central desert mountains, *Petroica multicolor campbelli* of the south-western sclerophylls, and isolates in north-eastern rain forest species (*Tregellasia capito nana, Monarcha trivirgata albiventris, Machaerirhynchus flaviventer secundus*).

Distributional barriers of fundamental importance in speciation in the Australian flycatchers may be summed up as areas of inhospitable terrain (from which the relevant habitat is absent) and areas of sea (*e.g.*, Torres Strait). It is significant that the land barriers breaking up the distribution of widely-ranging species tend to be the same from species to species and agree with those in other bird groups as well. Thus, in many species there is a distinctive north-eastern and north-western form isolated by the Gulf of Carpentaria and dry country about its head (*Rhipidura rufifrons, Myiagra rubecula, Piezorhynchus alecto.* (See Fig. 2.) A similar situation exists in the south where eastern and western populations of sclerophyll species are isolated by Spencer's Gulf and the Nullarbor Plain (*Eopsaltria australis, Petroica multicolor.* (See Fig 6.) Rain forest species have, in several instances, developed distinctive forms on either side of the gaps in that habitat in southern Cape York and southwards from Cardwell (Fig. 7). In odd instances, however, notably in the case of the savannah woodland *Seisura inquieta*, the isolating barrier is not readily apparent (Fig. 4).

Clinal variation, that, since no isolation is involved is of no immediate significance from the view point of speciation, is well developed in many Australian flycatchers. The bulk of the variation in the plastic *Rhipidura fuliginosa* (Fig. 1) comes into this category. The colour of *R. fuliginosa* would appear to be strongly influenced by the environment for populations inhabiting forested areas of high rainfall are dark grey in colour, whilst those in dry places are a lighter greyish-fawn. South-north clines of decreasing size (the ecophysiological basis of which is believed to be associated with questions of heat exchange) occur in many species, vide *Rhipidura leucophrys* (Fig. 3), *Petroica cucullata, Myiagra rubecula*, and others.

It might be noted, in conclusion, that the actual pigments in the make-up of species would appear to influence their potentiality to varying in colour geographically. Of six flycatchers that range widely through the continent the two that are grey-brown in colour (*Rhipidura fuliginosa* and *Microeca leucophaea*) vary in tone to a marked degree but the pied species (*Rhipidura leucophrys, Seisura inquieta, Petroica cucullata*) and the one in which black and red are dominant (male *Petroica goodenovii*) do not vary at all. The explanation obviously lies in the climate influencing some pigments but not others. It operates, of course, through the genotype, not the phenotype.

NEW NAMES

Genera: The name *Peneoenanthe* Mathews is reintroduced for the robin *Quoyornis leucurus* (R.A.O.U. *Checklist* 1926) = *Poecilodryas pulverulenta* (Mayr 1941).

NEW SYNONYMY

Genera: New synonyms are listed in brackets under the genera with which they have been grouped:

Genus *Monarcha* Vigors and Horsfield (synonym: *Carterornis*).

Genus *Petroica* Swainson (synonyms: *Amaurodryas* and *Melanodryas*).

Genus *Eopsaltria* Swainson (synonym: *Quoyornis*).

Races: New synonyms are listed in brackets under the races with which they have been grouped:

Rhipidura fuliginosa alisteri Mathews 1911 (synonyms: *victoriae* and *whitei*).

R. rufifrons rufifrons (Latham) 1801 (synonyms: *inexpectata, intermedia, kempi*).

R. r. dryas Gould 1842 (synonym: *parryi*).

R. rufiventris isura Gould 1840 (synonyms: *tormenti, macgillivrayi, superciliosa*).

R. leucophrys leucophrys (Latham) 1801 (synonym: *carteri*).

R. l. picata Gould 1848 (synonym: *utingu*).

Seisura inquieta inquieta (Latham) 1801 (synonym: *nea*).

S. inquieta nana Gould 1870 (synonym: *rogersi*).

Piezorhynchus alecto nitida Gould 1840 (synonym: *melvillensis*).

P. alecto wardelli Mathews 1911 (synonym: *campbelli*).

Myiagra rubecula rubecula (Latham) 1801 (synonym: *ringwoodi*).

M. rubecula concinna Gould 1847 (synonyms: *melvillensis* and *broomei*).

M. cyanoleuca (Vieillot) 1818 (synonym: *robinsoni*).

M. ruficollis mimikae Ogilvie-Grant 1911 (synonyms: *kempi, cooperi, tormenti.*

Monarcha frater periophthalmicus Sharpe 1882 (synonyms: *canescens, kurandi, claudia*).

M. trivirgata gouldi Gray 1860 (synonym: *stalkeri*).

M. leucotis Gould 1850 (synonym: *gracemeri*).

Microeca leucophaea leucophaea (Latham) 1801 (synonym: *victoriae*).

M. l. assimilis Gould 1840 (synonym: *howei*).

M. l. pallida De Vis 1884 (synonym: *subpallida*).

M. flavigaster flavigaster Gould 1843 (synonym: *melvillensis*).

M. f. terraereginae Mathews 1912 (synonym: *laetissima*).

Petroica multicolor boodang (Lesson) 1837 (synonyms: *leggii, halmaturina, frontalis*).

P. goodenovii (Vigors and Horsfield) 1827 (synonyms: *ramsayi, quoyi, ruficapilla, alexandrae*).

P. phoenicea Gould 1837 (synonyms: *addenda, albicans, tasmanica*).

P. rosea Gould 1839 (synonym: *queenslandica*).

P. rodinogaster (Drapiez) 1819 (synonym: *inexpectata*).

P. cucullata cucullata (Latham) 1801 (synonyms: *vigorsi, westralensis*).

P. c. picata (Gould) 1865 (synonyms: *subpicata, melvillensis*).

P. vittata (Quoy and Gaimard) 1830 (synonym: *bassi*).

Eopsaltria australis griseogularis Gould 1838 (synonyms: *wongani, quoyi*).

E. georgiana georgiana (Quoy and Gaimard) 1830 (synonym: *warreni*).

Peneoenanthe pulverulenta alligator (Mathews) 1912 (synonyms: *normani, greda*).

P. p. cinereiceps (Hartert) 1905 (synonym: *connectens*).

Heteromyias cinereifrons (Ramsay) 1875 (synonym: *athertoni*).

Poecilodryas superciliosa superciliosa (Gould) 1847 (synonym: *yorki*).

P. s. cerviniventris (Gould) 1857 (synonyms: *belcheri, derbyi, gregori*).

Tregellasia capito nana (Ramsay) 1878 (synonym: *barroni*).

Acknowledgments

To the authorities of the American Museum of Natural History, the Australian Museum, the National Museum of Victoria, the West Australian Museum and the Los Angeles County Museum I should like to express my sincerest thanks for the opportunity to study the necessary material. I am also indebted to Dr. E. Mayr for making his measurements of *Eopsaltria australis* available to me. Figs 1, 3 and 4 are the work of Mr. B. Bertram, Australian Museum.

References

Amadon, D. 1943. Bird weights as an aid in taxonomy. *Wilson Bull.* 55: 164.

Barnard, C. A. and Barnard, H. G. 1925. A review of the bird life on Coomooboolaroo Station, Duaringa District, Queensland, during the past fifty years. *Emu* 24: 252.

Bonaparte, C. L. 1850. *Conspectus Generum Avium.* E. J. Brill 1: 358.

Bourke, P. A. and Austin, A. F. 1947. The Atherton Tablelands and its avifauna. *Emu* 47: 87.

Campbell, A. G. 1909. The Flame-breasted Robin (*Petroica phoenicea*): a monograph. *Emu* 8: 122.

Condon, H. T. 1951. Notes on the birds of South Australia: occurrence, distribution and taxonomy. *S. Austr. Ornith.* 20: 37.

Elliott, A. J. 1938. Birds of the Moonie River District adjacent to the border of New South Wales and Queensland. *Emu* 38: 40.

Favaloro, N. J. 1930. Two Australian flycatchers. *Emu* 30: 161.

———————. 1931. Notes of a trip to the Macpherson Range, south-eastern Queensland. *Emu* 31: 49.

———————. 1953. Where 'Robins' meet. *Emu* 53: 223.

Fleming, C. A. 1950. New Zealand flycatchers of the genus *Petroica* Swainson. *Roy. Soc. N.Z. Proc.* 78: 14 and 127.

Gould, J. and Sharpe, R. B. 1875-1888. *The Birds of New Guinea and adjacent Papuan Islands.* Henry Sotheran, London 2: No. 42.

Iredale, T. 1956. *Birds of New Guinea.* Georgian House, Melbourne 2: 18.

Jarman, H. E. A. 1944. The Birds on Banka Banka Station, Northern Territory of Australia. *S. Austr. Ornith.* 27: 27.

———————, 1953. The R.A.O.U. camp-out in central Australia, 1952. *Emu* 53: 169.

Keast, A. 1957. Variation and speciation in the Australian Treecreepers (*Climacteris*). *Aust. J. Zool.* in press.

Lamm, D. W. and Calaby, J. H. 1950. Seasonal variation of bird populations along the Murrumbidgee in the Australian Capital Territory. *Emu* 50: 118.

Mack, G. 1931. The genus *Arses* in Australia. *Emu.* 31: 66.

———, 1953. Birds from Cape York Peninsula, Queensland. *Mem. Qld. Mus.* 13: 29.

Mathews, G. M. 1919-1920 and 1921-1922. *The Birds of Australia.* H. F. & G. Witherby, London, 8 and 9: 58 etc. and 1 etc.

———————. 1946. *A Working List of Australian Birds including the Australian Quadrant and New Zealand.* Shepherd and Newman, Sydney: 78.

Mayr, E. 1934. Notes on the genus *Petroica.* *Am. Mus. Novit.* No. 714: 11.

———————. 1941a *List of New Guinea Birds.* *Am. Mus. Nat. Hist.*, New York, p. 132, etc.

———————. 1941b. The generic classification of some New Guinea flycatchers (*Microeca-Poecilodryas* group). Notes on New Guinea birds VIII. *Am. Mus. Novit.* No. 1133: 6.

Mayr, E. and Amadon, D. 1951. A classification of recent birds. *Am. Mus. Novit.* No. 1496: 19.

Mayr, E. and Moynihan, M. 1946. Evolution in the *Rhipidura rufifrons* group. *Am. Mus. Novit* No. 1321: 15.

North, A. J. 1895. Preliminary descriptions of a new genus and five new species of central Australian birds. *Ibis* 17th Ser.: 340.

———————. 1903. *Nests and Eggs of Birds found breeding in Australia and Tasmania.* Australian Museum, Sydney 1: 139 and 185.

Prescott, J. A. 1931. The soils of Australia in relation to vegetation and climate. *Coun. Sci. Industr. Res. Aust. Bull.* No. 52: 1.

Serventy, D. L. and Whittell, H. M. 1948. *A Handbook of the Birds of Western Australia.* Patersons Press, Perth: 247.

Sullivan, C. 1931. Notes from north-western New South Wales. *Emu* 31: 124.

Terrill, S. E. and Rix, C. E. 1950. The birds of South Australia, their distribution and habitat. *S. Austr. Ornith.* 19: 82.

Thomson, D. F. 1935. *Birds of Cape York Peninsula.* Government Printer, Melbourne: 54.

Vaurie, C. 1953. A generic revision of flycatchers of the tribe Muscicapini. *Bull. Am. Mus. Nat. Hist.* No. 100: 530.

White, S. R. 1946. Notes on the bird life of Australia's heaviest rainfall region. *Emu* 46: 81.

Whitlock, F. L. 1924. Journey to Central Australia in search of the Night Parrot. *Emu* 23: 248.

Sydney: A. H. Pettifer, Government Printer—1957.

NEW UPPER PERMIAN HOMOPTERA FROM THE BELMONT BEDS

(HOMOPTERA: INSECTA)

By J. W. EVANS,
Australian Museum.

(Figures 1-5)

(Manuscript received 30.8.57)

The five wings of Upper Permian Homoptera which are described and figured here are all of particular interest. Four are of insects belonging to the Family Archescytinidae and the fifth is of a Cercopoid.

The wings of Archescytinids, which are the only Homoptera recorded from Lower Permian strata in Kansas, exhibit many primitive features. Thus, the fore and hind wings are similar in shape and venation, the venation has a simple basic pattern of arrangement and the clavus is small. Their occurrence, together with their probable derivatives, the Scytinopteridae, in Upper Permian beds in New South Wales is not unexpected, as both families are already known to occur in Upper Permian strata in Russia. A single wing (*Austroscytina imperfecta* Evans) formerly ascribed to this Family, only doubtfully belongs to it (Evans 1956).

The Cercopoid is ascribed to the Family Eoscarterellidae, and represents the first member of this Superfamily to be recorded from strata of Permian age.

The types and single other specimen described are in the collection of the Australian Museum.

ARCHESCYTINIDAE

Eoscytina gen. nov.

The forewing is considerably wider towards the apex than at the base. R, from near its base as far as its separation with R1a and R1b, is parallel with the costal margin. Rs arises from R approximately midway between the junction of R with M and the forking of R1. The number of branches of M are unknown, but are probably four. Cu1 is steeply bent at its point of apposition to R + M. Cu1a is angulate, joined to M by a cross-vein and greater in length than the basal straight portion of Cu1. Cu1b meets the hind margin of the forewing at a considerable distance from the apex of Cu2. The clavus is small and the anal veins form a Y-vein. Type species, *Eoscytina migdisovae* sp. nov.

Eoscytina resembles other genera of the Archescytinidae in the size of the clavus, the steep basal bend of Cu1 and in the apical separation of Cu1b and Cu2. It differs in the proportional length of Cu1a to the rest of Cu1 and in the apparent absence of Sc lying closely apposed to R. It resembles even more closely the wings of certain Homoptera in the family Boreoscytidae (Bekker-Migdisova 1949), but differs from them in having Rs simple and not branched.

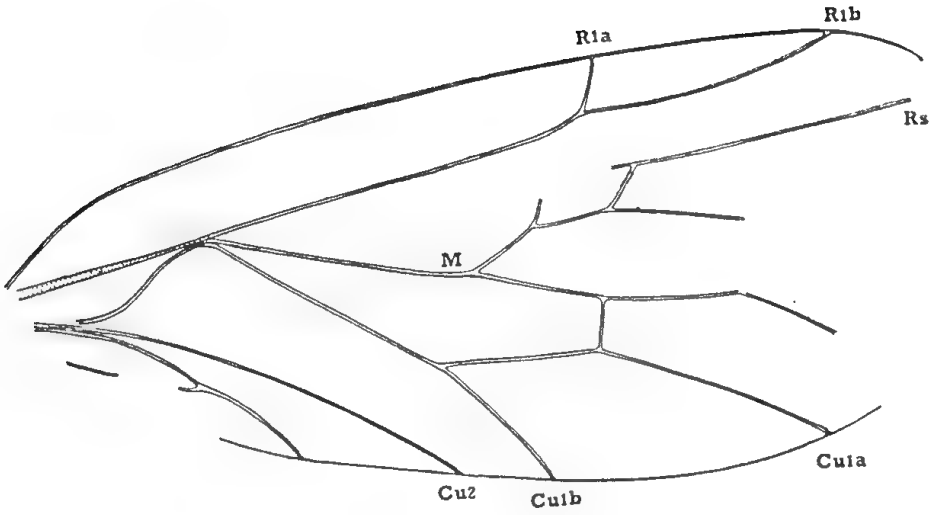


FIGURE 1.
Eoscytina migdisovae, forewing.

Eoscytina migdisovae sp. nov.

(Figs. 1, 2)

Length of holotype tegmen, 9 mm; greatest width, 3.5 mm. Another specimen, F47185 (Fig. 2), length of fragment 7.8 mm, greatest width, 3 mm.

Holotype tegmen, F47189 (Fig. 1). Both tegmina from Upper Permian strata, Belmont, New South Wales.

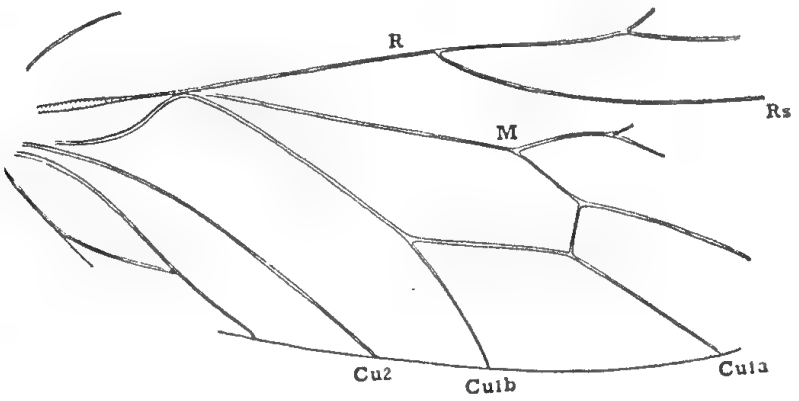


FIGURE 2.
Eoscytina migdisovae, forewing.

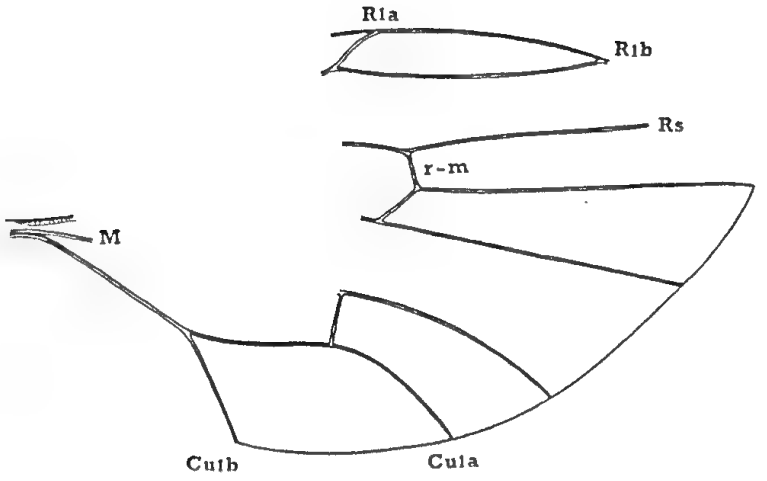


FIGURE 3.
Eoscytina incompleta, hindwing.

Eoscytina incompleta sp. nov.

(Fig. 3)

Length of fragment of hindwing, 7 mm; greatest width, 4.6 mm.

Holotype wing, F47191, from Upper Permian strata, Belmont, New South Wales.

This fragment of a hindwing is placed in the genus *Eoscytina* because of its resemblance to the tegmen of *E. migdisovae* in the characters of a wide radial cell and the shape of Cu1a.

Bekkerscytina gen. nov.

The forewing is elongate-oval in shape. The costal space is wide and R is not parallel with the costal border. Rs arises from R nearer to the point of separation of R from R + M than to the fork of R1. M has three branches, M1, M2 and M3 + 4. Cu1 is strongly bent basally; Cu1a which is not angulate is slightly longer than the straight portion of Cu1 and Cu1b meets the margin of the wing distally of Cu2. Cross-vein m—cu is present. The clavus is small and the two anal veins are separate for their entire lengths.

Type species, *Bekkerscytina primitiva* sp. nov.

The tegmen of *Bekkerscytina* differs from that of *Eoscytina* in shape, in the earlier departure of Rs and in the separate condition of the anal veins.

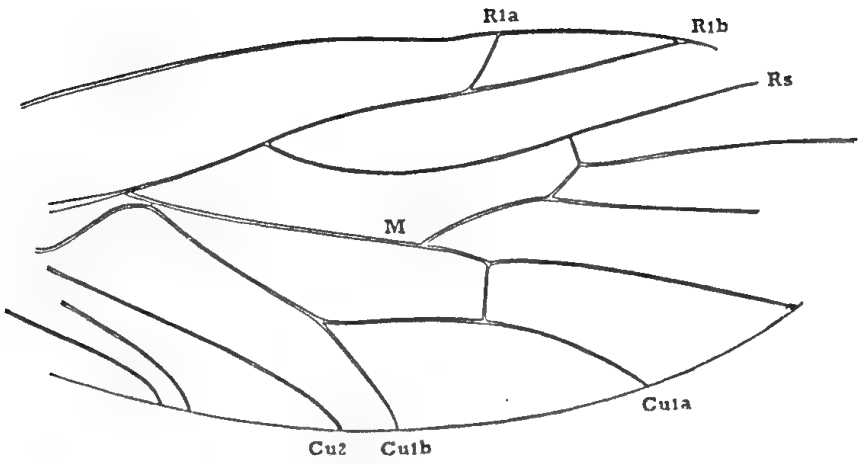


FIGURE 4.
Bekkerscytina primitiva, forewing.

Bekkerscytina primitiva sp. nov.

(Fig. 4)

Length of holotype tegmen 7.8 mm; greatest width 4.8 mm.

Holotype tegmen F47190, counterpart 47184, from Upper Permian strata, Belmont, New South Wales.

CERCOPOIDEA

EOSCARTERELLIDAE

Belmontocarta gen. nov.

Upper Permian Homoptera with rugose tegmina which are considerably wider apically than at the base. Sc is present as a short vein curving distally towards the base of R+M. R1a is a single vein and R1b branched and linked with Rs by an oblique cross vein. M has 4 branches and M1 and M2 are considerably longer than M3 and M4. Cu1, which is basally parallel with R + M, is joined to the base of M by a short cross vein; Cu1a is evenly arched, while Cu1b is in alignment with the margin of the tegmen. Cross veins r-m and m-cu are present. Type species, *Belmontocarta perfecta* sp. nov.

Belmontocarta differs from the Triassic genus *Eoscarterella* Evans, to which it has close affinities, principally in the shape of Cu1, which is curved in the tegmina of *B. perfecta* and straight in *Eoscarterella* spp.

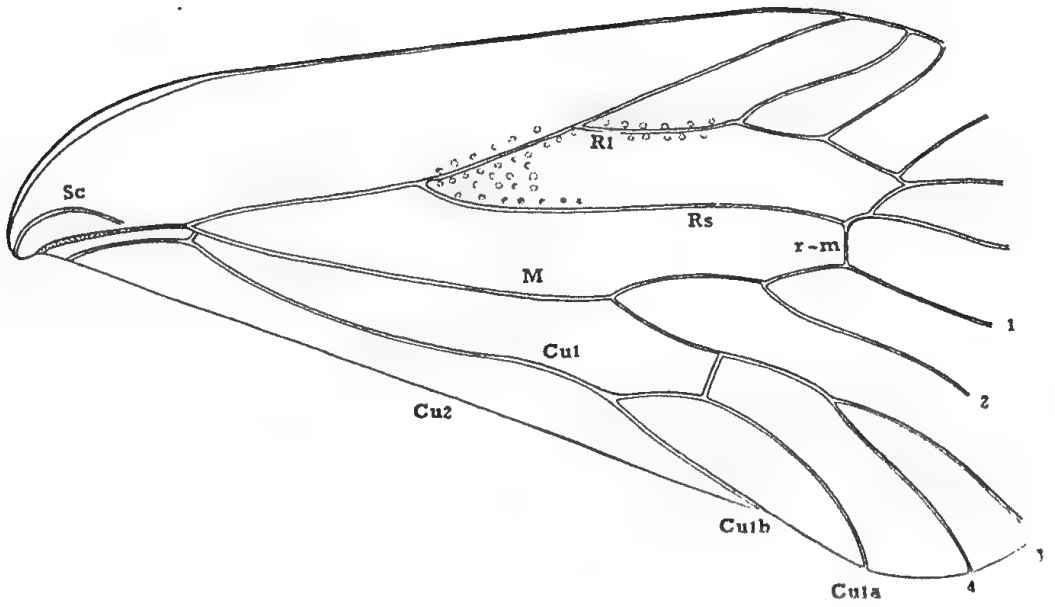


FIGURE 5.

Belmontocarta perfecta, forewing.

Belmontocarta perfecta sp. nov.

(Fig. 5)

Length of preserved portion of tegmen, 10.5 mm; greatest width 4.8 mm. Tegmen coarsely rugose except apically where it is smooth, suggesting an apical overlap of folded tegmina. Rlb with 4 branches extending to the margin of the tegmen. Clavus missing.

Holotype tegmen F47199, from Upper Permian strata, Belmont, New South Wales.

Formerly (Evans 1956) the family Eoscarterellidae was placed only provisionally in the Cercopoidea due to the fact that M and Cul were separate basally. Further consideration of the possible relationship of the three genera now comprised in this family renders more certain its Cercopoid affinities. Characteristics in which these tegmina differ from those in the Cicadelloid complex and resemble Cercopoidea are the presence of a short Sc, a branched Rlb, features associated with the shape of Cul and a rugose tegmen which is considerably wider apically than basally. Certain Scytinopterids also have a multi-branched Rlb (*e.g., Orthoscytina, Triassoscytinopsis, Triassoscelis*) but in these Cu1b is not in alignment with the margin of the tegmen. Furthermore, although M and Cu1 are not fused basally in Eoscarterellids, they are not separated as widely from each other as is the case with most Scytinopterids.

SUMMARY

Five wings of Upper Permian Homoptera from New South Wales are described and figured. One is of a Cercopoid, and four of insects belonging to the Family Archescytinidae. They represent respectively the first record of a Cercopoid from Permian strata and the first undoubted Archescytinids from Upper Permian strata in New South Wales.

References

Bekker-Migdisova, H. E. 1949. *Trav. Inst. Paléozool. Acad. Sci.: U.R.S.S.* 20: 171.

Evans, J. W. 1956. Palaeozoic and Mesozoic Hemiptera. *Aust. J. Zool.* 4: 165.

Sydney: A. H. Pettifer, Government Printer—1957.

THE PERMIAN GASTROPODS OF NEW SOUTH WALES

By H. O. Fletcher

(Plates 7–21)

(Manuscript received 4.9.57)

SUMMARY

The Permian gastropod fauna of New South Wales is revised and 7 new genera and 16 new species are described and figured.

For the purposes of correlation gastropods have proved to be an unsatisfactory group. This is because they appear to be very susceptible to environmental changes and many species develop within a sequence to a marked extent in comparatively narrow limits both horizontally and vertically. Some species, however, form valuable " marker " or " index " fossils for certain horizons of limited extent.

In this paper a correlation of the Permian horizons in New South Wales is made, so far as is possible, from a study of the gastropod fauna. Special attention is directed towards the uncertain correlations of the " rock unit subdivisions " of the South Coast with those of the Hunter River Valley.

The study of the Permian gastropods has led to certain interesting correlations, but attempts made to correlate the complete sequence of Permian rocks of the South Coast with those of the Hunter River Valley have been impossible.

INTRODUCTION

Rocks of Permian age cover considerable portions of fairly widely separated areas in New South Wales. A great deal of attention has been directed to these rocks for more than a century because of the economic importance of the coal seams found in the Upper Coal Measures, the Greta Coal Measures and their equivalents.

The type locality of the Permian rocks in New South Wales is in the lower Hunter Valley where a complete and continuous sequence occurs. In this area, as well as over most of the Sydney Basin, the Newcastle Coal Measures pass upwards without angular unconformity into the overlying Narrabeen Group of Lower Triassic age. The basal glacial shales of the Permian rest also without angular unconformity upon the Kuttung Group of the Carboniferous.

The geology of the Permian areas in New South Wales has been thoroughly investigated over the years and the stratigraphy is well known, particularly in the Hunter River Valley. There is still some doubt, however, regarding the exact succession of " rock units " of the Upper Marine Series which are found outcropping on the South Coast from Wollongong to near Durras Waters a few miles north of Bateman's Bay.

The great abundance and variety of well preserved fossils found in both the Maitland (Upper Marine) and Dalwood (Lower Marine) Groups and their equivalents, has attracted the attention of palaeontologists in the past and many important contributions to knowledge have been published. Nevertheless knowledge of the marine fauna is inadequate and surprisingly incomplete.

HISTORICAL REVIEW OF PERMIAN GASTROPODS WITHIN NEW SOUTH WALES

The first Permian gastropod from New South Wales was recorded in 1838 when James D. Sowerby figured, but did not describe, a medium sized shell as " The *Trochus* . . . . may be called *T. oculus* ". His figures of this specimen were idealised to some extent and photographs provided by the British Museum have proved certain inaccuracies.

The location of this specimen is mentioned by Mitchell (1838) as : " A hill of some height on the right bank, situate some twenty-six miles from the sea-shore, is composed chiefly of a volcanic grit of greenish-grey colour, consisting principally of felspar, and being in some parts slightly calcareous, in other parts highly calcareous when the rock assumes a compact aspect . . . . . This rock contains numerous fossils." This hill in the Hunter River Valley, now known as Harper's Hill, is the type locality for many fossil species. On the same horizon, the Allandale Formation of the Dalwood (Lower Marine) Group, are nearby localities referred to in literature as Allandale, Duguid's Hill, and " Lochinvar ", a locality occasionally listed for early material obviously collected at Harper's Hill.

A series of gastropods collected from Harper's Hill, Glendon and Illawarra by P. E. de Strzelecki was described by J. Morris (1845 : 285—288). The specimens are housed in the collection of the British Museum. The name Illawarra now refers to a district of considerable extent on the South Coast, but it is almost certain that Strzelecki collected his fossils at Wollongong, about 50 miles south of Sydney. Glendon is a locality in the Hunter River Valley which is referred to by several of the early authors, but there is doubt regarding its actual geographical position. The locality was usually accepted as being on the northern bank of the Hunter River about 9 miles east of Singleton. This must be incorrect as the exposed rocks in that area are unfossiliferous.

On a geological map of New South Wales and Van Diemen's Land, prepared by Strzelecki (1845, insert), the locality referred to as Glendon is marked on an unnamed creek about 5 miles north of its junction with the Hunter River. The locality could therefore be on Wattle Ponds Creek which flows into Glendon Brook. It is possible that the fossil horizon is in the Belford Formation of the Maitland (Upper Marine) Group although the described fossils also appear to indicate an association with the fauna of the underlying Fenestella Shale Formation. Further careful investigation is needed in this area before this rather important point can be cleared satisfactorily and the exact original locality of Glendon becomes known.

Morris (1845 : 285—288) described and figured the following gastropods :—

Platyschisma oculus (Sowerby).= *Trochus oculus* Sowerby. Harper's Hill.

Platyschisma rotundatum Morris. Harper's Hill.

Pleurotomaria strzeleckiana Morris. Glendon and Illawarra.

Pleurotomaria subcancellata Morris. Illawarra.

Bellerephon micromphalus Morris. Illawarra.

He also recorded from Illawarra " another species of *Pleurotomaria*, nearly related to *P. conica* Phillips, in having a bicarinated mesial band, and numerous small, oblique, rather acute striae on each volution; it differs however from that species in being smaller, more elongated and acutely conical ". This shell was later described and figured by M'Coy (1847) as *Pleurotomaria morrisiana*. Most of the material described by Morris is stored in the collection of the British Museum.

It is considered most unlikely that *Platyschisma rotundatum* was ever found in abundance at Harper's Hill, as recorded by Morris, or even if it ever occurred there. The specimen figured by that author (1845 : pl. xviii, fig. 2) is a typical example of the species found at Wollongong and in my opinion an error in the labelling of the specimens must have occurred. M'Coy (1847 : 306) repeated the error when he listed *Platyschisma rotundatum* (Morris) as " abundant in the dark arenaceous limestone of Harper's Hill, New South Wales ". Recent investigations have shown that this species does not occur in the Dalwood (Lower Marine) Group and its equivalents, but is common in the Maitland (Upper Marine) Group and particularly in its equivalents of the South Coast and Western Coalfield Provinces.

In a description of the Palaeozoic Formations of New South Wales and Van Diemen's Land, J. Beete Jukes (1847 : 242) listed two species of gastropods from Wollongong. These were identified by Sowerby as *Pleurotomaria strzeleckiana* and *Bellerephon contractus*, MSS., sp. nov. The latter name has no validity as it was never described or figured. It is almost certain to be the same species as described by Dana (1847 : 150) from the same locality as *Bellerephon strictus*. The specimens collected by Jukes are now in the British Museum, having been transferred from the Geological Society's Museum (London) in 1911.

In September, 1847, Frederick M'Coy (1847 : 305—308), when describing a collection of fossils made by the Rev. W. B. Clarke, included a number of Permian gastropods. He described and figured *Pleurotomaria morrisiana* from Black Head, near Gerringong, and also mentioned it was rare in the sandstone at Muree in the Hunter River Valley. Other known species recorded by M'Coy consist of *Pleurotomaria subcancellata* Morris, from Loder's Creek; *Pleurotomaria strzeleckiana* from Wollongong; *Platyschisma rotundatum* Morris and *P. oculus* (Sowerby) from Harper's Hill; *Bellerephon micromphalus* Morris from Wollongong and rare in the sandstone of Muree.

Two months after the publication of M'Coy's studies, J. D. Dana (1847 : 150—160) described a collection of fossils collected in New South Wales in 1839 by the Exploring Expedition under the command of Charles Wilkes, U.S.N. The specimens were collected from " the lower layers of the coal formation in Illawarra, and from a deposit of probably nearly the same age at Harper's Hill, valley of the Hunter ". The paper was a preliminary report in which Dana described but did not figure the species he dealt with. The gastropods are as follows :—

Harper's Hill (Hunter River Valley)—

Bellerephon undulatus Dana.

Platyschisma ? depressum Dana.

Pleurotomaria nuda Dana.

Patella tenella Dana.

Pleurotomaria trifilata Dana. (Also at Illawarra).

Illawarra (Wollongong)—

Bellerephon strictus Dana.

Natica .....?

Dana (1849 : 706—708) redescribed and figured the above gastropods, together with additional species, and made certain changes in nomenclature as follows :

Harper's Hill—

Pileopsis tenella Dana.=*Patella tenella* Dana.

Pileopsis alta Dana.

Pleurotomaria morrisiana Morris.=*P. trifilata* Dana. (Also found at Black Head, Gerringong).

Pleurotomaria nuda Dana.

Platyschisma oculus (Sowerby).

Platyschisma depressum Dana.

Bellerephon undulatus Dana.

Illawarra. (Wollongong and Black Head)—

Pleurotomaria strzeleckiana Morris.

Platyschisma rotundatum Morris.

Natica .... ?

Bellerephon strictus Dana.

Bellerephon micromphalus Morris.

The type specimens of the species described and figured by Dana are in the U.S. National Museum, while duplicate specimens and plastotypes are in the Peabody Museum, Yale University.

A list of Permian fossils from several localities in the Hunter River Valley and from Illawarra was recorded by M. J. Grange (1854 : 86—89) in Dumont D'Urville's *Voyage au Pôle Sud : Géologie.* The gastropods consist of species already described by earlier authors and no new forms were mentioned.

A very large collection of Palaeozoic fossils made by the Rev. W. B. Clarke was described by Professor L. G. de Koninck (1877). This work, written in French, was translated by Professor and Mrs. T. W. E. David and Mr. W. S. Dun and was republished in 1898 as *Memoir of the Geological Survey of New South Wales : Palaeontology No.* 6. The types and named specimens of the Clarke collection were on Mr. Clarke's death, purchased by the Government of New South Wales, but unfortunately they were completely destroyed in the Garden Palace fire in Sydney in 1882.

The Permian gastropods described and figured by de Koninck are :

Platyceras alta (Dana).=*Pileopsis alta* Dana. A small specimen from Lower Carboniferous rocks at Pallal and is not the typical *P. alta* of Dana.

Pleurotomaria morrisiana M'Coy. Minnamurra, near Black Head, Gerringong.

Pleurotomaria subcancellata Morris. Muree, Hunter River Valley.

**Pleurotomaria striata* Sowerby. Duguid's Hill (Harper's Hill), Hunter River Valley.

**Pleurotomaria gemmulifera* Phillips. Railway cutting between Maitland and Stony Creek, Hunter River Valley.

Pleurotomaria humilis de Koninck. Raymond Terrace, Hunter River Valley.

**Pleurotomaria naticoides* de Koninck. Harper's Hill.

Murchisonia trifilata (Dana).=*Pleurotomaria morrisiana* Dana (non M'Coy). Harper's Hill.

**Murchisonia verneuiliana* de Koninck. Minnamurra, near Black Head, Gerringong.

Euomphalus oculus (Sowerby).=*Platyschisma oculus* (Sowerby). Harper's Hill; Branxton; Hunter River Valley.

Goniatites micromphalus (Morris).=*Bellerephon micromphalus* Morris.=*Bellerephon undulatus* Dana. Muree.

Goniatites strictus (Dana).=*Bellerephon strictus* Dana. Harper's Hill.

The species marked * are European forms and are questionable determinations. Some of de Koninck's species are poorly figured and in some cases it is impossible to come to any definite conclusions in regard to their relationships. No attempt has been made to apply present nomenclature to de Koninck's species and the names are those given by him. These problems are dealt with later in this paper.

Robert Etheridge, jnr. made a number of contributions to our knowledge of the Permian gastropod fauna of New South Wales. That author (1878 : 89) listed " *Goniatites micromphalus* " (Morris) as doubtfully related to *Aganides* Montford (1880 : 304), and recorded the species from the Bowen River coalfield in Queensland. This reference was repeated by Etheridge (1892 : 294).

Waagen, after a study of the bellerephontids from the Productus Limestone of the Salt Range in India, introduced a new genus *Warthia* for shells which showed no trace of a slit-band and were strongly involute and compressed. He (1880 : 160) stated that in his opinion the Australian species *Bellerephon undulatus*, *B. strictus* and *B. micromphalus* undoubtedly belonged to this genus.

Etheridge (1889 : 205; 1897 : 15) described and figured a gastropod from the Permian rocks in north-western Australia as *Pleurotomaria humilis* of de Koninck, a species described from Raymond Terrace in the Hunter River Valley. Etheridge referred the species to the genus *Mourlonia*, but in my opinion it is most unlikely that the two forms are conspecific.

Etheridge (1894 : 36) described and figured the surface sculpture and suture lines which for the first time were found preserved on a specimen of what was considered to be " *Goniatites micromphalus* (Morris) ". This specimen, together with two other apparently similar shells, but showing no sutures, were obtained from the shaft of the Maitland Colliery Company, near Farley, in rocks of the Branxton Sub-group of the Maitland (Upper Marine) Group. On the evidence of the suture lines, Etheridge referred the species to *Goniatites* (*Prolecanites* ?) and included, incorrectly as is now known, all the specimens previously classified as *Bellerephon micromphalus* of Morris.

In the same year and having had access to Etheridge's paper, Foord and Crick noted the resemblance of Etheridge's specimens, particularly the suture lines, to *Agathiceras uralicum* Karpinsky from the Artinsk beds of Russia, and they therefore referred the species with reservation to the genus *Agathiceras*.

Two years later, however, Frech (1896 : 501) stated that the general form and spiral ornaments of this species agree with *Gastrioceras*, while its lobes agree with those of *Prolecanites* or *Pronorites*. At that time a complete suture was not known as Etheridge had only figured a few lobes and saddles, and Frech thought that when this was known the species might possibly have to be referred to a new genus.

The species continued to be listed as *Agathiceras* in many papers dealing with the Permian of Australia, but with no comments. Several foreign references to this Australian species, which are not of great importance but which might be mentioned, are Haug (1898 : 23) and Haniel (1915).

Two new species of *Platyceras* from Harper's Hill were described and figured by Etheridge (1896 : 14) as *Platyceras* (*Orthonychia*) *cornucapella* and *P.* (*O*). *ungula*. *Pileopsis alta* of Dana, from the same locality was redescribed as *Platyceras* (*Orthonychia*) *altum* ? (Dana), while several specimens from the Maitland (Upper Marine) Group at West Maitland, were at the same time described as *Mourlonia ? waterhousei*.

Etheridge (1898 : 176) described and figured what he considered was a depressed form of *Platyschisma oculus* (Sowerby) from the type locality at Harper's Hill. From the same locality he later (1902 : 195) instituted a new genus and species as *Keeneia platyschismoides* and a new species *Straparollus ammonitiformis*, both being gastropods of considerable size.

The bellerephontid affinities of " *Agathiceras micromphalus* (Morris) " were favoured in a paper by Girty (1908) when he stated that in all probability the species would prove to be a *Warthia*.

Laseron (1910 : 220—222) recorded *Platyschisma oculum* (Sowerby), *Mourlonia strzeleckiana* (Morris), *Ptychomphalina morrisiana* (M'Coy) and *Agathiceras micromphalus* (Morris) from various localities in the Lower Shoalhaven River area of the Illawarra district. He also briefly described two single specimens, both of which have been lost, as *Capulus* sp. indet., and *Euomphalus* ? sp. These were from the higher formations of the Shoalhaven Group, which are the equivalent, in part, of the Branxton (Upper Marine) Sub-group of the Hunter River Valley. It is thought that Laseron's *Capulus* sp. indet. which he figured, is identical with *Strotostoma nichollsi*, a new genus and species described in this paper. Laseron did not figure *Euomphalus* ? sp., a small four-whorled shell with the spire depressed below the later whorls, and until additional specimens come to hand from the same locality the identity of this form must remain doubtful.

A rather low-spired form of gastropod from the Tasmanite Spore Beds of the Mersey River, Tasmania, was described and figured by Dun (1913 : 8) as *Keeneia twelvetreesi*. This is an important species as there is some doubt regarding the age of the Tasmanite beds. On palaeontological evidence they were previously recorded as equivalent, in part, with the Maitland (Upper Marine) Group of the Hunter River Valley of New South Wales. However, in a paper presented to the 1956 International Geological Congress, M. Banks suggested it was more probably equivalent to an horizon low in the Dalwood (Lower Marine) Group. Miss I. Crespin (verbal communication) considers that recent research on the fossil foraminifera of the area supports that conclusion.

The holotype of *Keeneia twelvetreesi* Dun has been mislaid but an examination of the figure (Dun 1913 : pl. ii), indicates a close relationship with *Planikeeneia insculpta* sp. nov., from the Allandale Formation, Dalwood (Lower Marine) Group, at Harper's Hill. The Tasmanian species is, however, maller but agrees otherwise in all essential feat res, particularly in the ornamentation being strongly inflected at the centre of the body whorl.

Etheridge (1919 : 188—189) discussed the characters of *Platyschisma oculus* (Sowerby), *P. rotundatum* Morris and *P. depressum*. He considered that *P. depressum* was a species of his genus *Keeneia*. A large series of internal casts of a small gastropod from the Farley Formation, Dalwood (Lower Marine) Group, were also described and figured in this paper as *Platyschisma rotundatum* var. *farleyensis*.

From the Permian rocks of Timor, Wanner (1922 : 55) described and figured ? *Capulus* cf. *tenellus* (Dana). He considered that his specimens have a close similarity with *Platyceras tenella* of Dana from the Hunter River Valley, but it is almost certain that the two forms are not conspecific and any resemblance is homeomorphic.

Mitchell (1922 : 278) described and figured a large depressed form of gastropod as *Platyschisma allandalensis* from rocks of the Allandale Formation exposed in a railway cutting near Allandale railway station. This species is considered identical with the species described by Dana as *Platyschisma depressum* from the same horizon.

An additional contribution to the status of " *Agathiceras micromphalus* (Morris) " was made by Whitehouse (1926) when, apparently recognising its true affinities, he listed it among Permian species from eastern Australia as " *Bellerephon* (*Warthia*) *micromphalus* ". No further observations were however communicated and in 1928 " *Agathiceras micromphalum* " was again mentioned from the Permian of Australia by Schuchert.

In 1929, Thomas reported that he and Dr. Spath had examined specimens of the alleged *Agathiceras micromphalum* from Australia and considered they could well be bellerephontids. In the same year Reid (1929 : 80) published a communication received from Whitehouse to the effect that " two similarly coiled species, a common gastropod, and a rare cephalopod, have been referred to the one species by earlier writers ", in particular by Etheridge in 1894. This is the first suggestion that the specimens which had been given the specific name *micromphalus* might not necessarily all be conspecific and that the name had been applied to gastropods as well as to a cephalopod.

Reed (1930 : 43) in describing some Permian fossils from Brazil which closely resembled the species of Morris, as " *Bellerephon* ? cf. *micromphalus* ", stated that the true position of the species must remain an open question.

Two years later, Reed (1932 : 69) identified *Warthia micromphala* (Morris) from the Agglomeratic Shales of Kashmir and commented that it was strange that no other author had been able to confirm the presence of septa, as observed by Etheridge, on any specimens referred to that species.

David and Sussmilch (1931 : 500) stated that " the only specimen of an *Agathiceras* found in Australia at that time and showing a suture, and referred by Etheridge to *Agathiceras micromphalum*, was obtained from a shaft sunk in the Upper Marine Series, at a horizon a few hundred feet above the top of the Greta Coal Measures ". The authors drew attention to the fossil classed as *Agathiceras micromphalum*, abundant in the Ravensfield Sandstone, but now considered to be a *Bellerephon*. On the same page Whitehouse is quoted as considering that the affinities of the ammonoid were nearer to *Paralagoceras* than to *Agathiceras*.

The next contribution to this problem was a paper by the author in collaboration with Dr. C. Teichert (Teichert and Fletcher 1943 : 156—163). It was shown that the only true ammonoid found in the Permian rocks of Australia consisted of a single specimen and it was described and figured as *Adrianites* (*Neocromities*) *meridionalis*. This was the specimen on which suture lines were observed and recorded by Etheridge in 1894. The question whether or not all the aseptate specimens from the Permian of New South Wales are in fact conspecific with Morris's holotype of *Bellerephon micromphalus* was not discussed. This question is dealt with later in this paper.

It is interesting to note that two additional ammonoids have since been found in the Permian of Australia. One species was described by Teichert from Western Australia while a second species was described by the same author (1954) as *Pseudogastrioceras pokolbinense*, from the Farley Formation of the Dalwood (Lower Marine) Group in Portion 74, Parish of Pokolbin, 3 miles south-west of Cessnock.

References to the Australian Permian gastropods have appeared in the very helpful works of J. Brookes Knight (1941) and Carl C. Branson (1948).

In the list of the gastropods previously recorded from the Permian of New South Wales the nomenclature and synonyms are given as accepted prior to the present study.

Old Names	New Names
Bellerephon contractus Sowerby (nom. nud.)...	*Warthia stricta* (Dana).
Bellerephon micromphalus Dana (non Morris 1845)	*Warthia perspecta* sp. nov.
Bellerephon micromphalus Morris (non Dana 1849)	*Warthia micromphala* (Morris).
Bellerephon strictus Dana	*Warthia stricta* (Dana).
Bellerephon undulatus Dana	*Warthia micromphala* (Morris).
Capulus sp. indet. Laseron	*Strotostoma rylstoni* sp. nov.
Euomphalus ? sp. Laseron	Indeterminate. Poor description and figure. Specimen lost.
Goniatites micromphalus Koninck (non Morris)	*Warthia micromphala* (Morris).
Goniatites (*Prolecanites*) *micromphalus* Etheridge (in part)	*Warthia perspecta* sp. nov.
Keeneia platyschismoides Etheridge... ...	*Keeneia platyschismoides* Etheridge.
Keeneia twelvetreesi Dun	*?Planikeeneia insculpta* sp. nov.
Mourlonia ? *waterhousei* Etheridge	No additional specimens.
Natica ? Dana	Indeterminate. Poor description and figure.
Patella tenella Dana.=*Pileopsis tenella* Dana.= *?Capulus* cf. *tenellus* Wanner	*?Rhabdocantha ungulum* (Etheridge.)
Pileopsis alta Dana.=*Platyceras altum* Koninck.=*Platyceras* (*Orthonychia*) *alta* (Etheridge)	*Rhabdocantha alta* (Dana).
Platyceras (*Orthonychia*) *cornucapella* Etheridge	*Rhabdocantha cornucapella* (Etheridge).
Platyceras (*Orthonychia*) *ungulum* Etheridge	*Rhabdocantha ungulum* (Etheridge).
Platyschisma allandalensis Mitchell	*Planikeeneia depressum* (Dana).
Platyschisma depressum Dana	*Planikeeneia depressum* (Dana).
Platyschisma oculus (Sowerby)	*Keeneia ocula* (Sowerby).
Platyschisma rotundatum Morris	*Platyschisma rotundatum* Morris.
Platyschisma rotundatum var. *farleyensis* Etheridge	*Planikeeneia occasa* sp. nov.
Pleurotomaria gemmulifera Koninck 1877 (non Phillips 1836)	No additional specimens. (Koninck's specimen destroyed by fire).
Pleurotomaria humilis Koninck.=*Mourlonia humilis* Etheridge	No additional specimens. (Koninck's specimens destroyed by fire).
Pleurotomaria morrisiana M'Coy	*Pleurocinctosa trifilata* (Dana).
Pleurotomaria naticoides Koninck 1877 (non 1843)	No additional specimens.
Pleurotomaria nuda Dana	*?Pleurocinctosa nuda* (Dana).
Pleurotomaria striata Koninck 1877 (non Sowerby 1828)	No additional specimens.
Pleurotomaria strzeleckiana Morris	*Mourlonopsis strzeleckiana* (Morris).
Pleurotomaria subcancellata Morris	*Walnichollsia subcancellata* (Morris).
Pleurotomaria trifilata Dana	*Pleurocinctosa trifilata* (Dana).
Straparollus ammonitiformis Etheridge ...	*Paromphalus ammonitiformis* (Etheridge).
Trochus oculus Sowerby	*Keeneia ocula* (Sowerby)
Warthia (see Bellerephon)	

SYSTEMATIC CLASSIFICATION

Unless otherwise mentioned all localities are in New South Wales and rock formations belong to the Permian. The type material is in the collection of the Australian Museum, Sydney.

Class **Gastropoda**

Sub-Class **Prosobranchia**

Order **Archaeogastropoda**

Super-Family **Trochonematacea**

Family **Platyceratidae** Hall 1859.

Genus **Rhabdocantha** nov.

(*Rhabdos*, striae; *akantha*, spine)

Type Species: *Pileopsis alta* Dana 1849.

Description.—Small to medium sized, almost symmetrical cone to arcuate univalves; shell rapidly narrowing towards apex which is very slightly twisted to one side, never in contact; cross-section of valve elliptical to oval. Apertural margin not thickened, regular with no sinuations. Ornamentation consists of numerous transverse and longitudinal fine, somewhat crenulate lirae.

Discussion.—Etheridge (1896 : 14) described three species of gastropod shells and referred them to the genus *Platyceras* Conrad, finally assigning them to the " sub-generic section " *Orthonychia* Hall He outlined the characters of *Orthonychia* as " shell arched or straight, elongately conical; the apex recurved but not spiral or enrolled; surface concentrically striate ". According to Etheridge the four sectional divisions mentioned by him in his paper were only of use in extreme forms and he agreed with Meek and Worthen (1868 : 487) that it is often difficult to separate them owing to gradations by which they blend one into the other.

Knight (1934 : 147) states that the genus *Platyceras* Conrad should be limited to forms with the earlier whorls coiled and in contact, but the last whorl free. This is the accepted version of the genus and as such prevents the inclusion of most Permian Australian Platyceratidae. The same author, in his discussion of the genus *Orthonychia* Hall, includes those shells which generally show some degree of spiral twist and often an arcuate curvature, but there is no true coiling even in the nucleus. *Orthonychia* as a genus was abandoned by Hall as he did not consider that it was distinct from *Platyceras*. This course was followed by other authors, but Knight (1934 : 148) rightly considered it should be retained with *Platyceras subrectum* Hall, 1859, as the type species. Bowsher (1955 : 1) departed from the general opinion and stated that "as used in this paper, the name *Platyceras* Conrad (1840) includes such sub-genera as *Orthonychia*. . . ."

Grabau (1936 : 312) introduced the genus *Geronticeras* for three species of horn-shaped gastropods from the Lower Permian rocks of the Kweichow Province, China, designating *G. latum* as the type species. These shells appear to have some affinities with the Australian species of *Rhabdocantha*. Knight (1941 : 129) is of the opinion that *G. latum* is congeneric with *Pileopsis vetusta* Sowerby, the genotype of *Platyceras*, and should therefore be referred to that genus.

After an examination of Grabau's figures, it seems to me that *Geronticeras dubium* of Grabau (1936 : pl. xxx, figs. 9a-d), is the species which should be referred to the genus *Platyceras*. The apical portion is closely enrolled for about one and one-fourth volutions and is in contact. In the other two species *G. latum* and *G. separatum*, the apex of the shell is barely enrolled and although the beak is twisted to one side the shells are more symmetrical than in *G. dubium*. It is these species which bear some resemblance to the shells from New South Wales, but differ in being far more twisted at the apex and irregular in their growth.

Some authors are of the opinion that a distinction is not possible between the genera *Platyceras* and *Capulus*. Wanner (1922 : 47) agreed with Keys (1890 : 150) that this was the case and that the latter name should be used as it had more than thirty years precedence over the former. Knight (1934 : 146) considers that any resemblance between *Capulus* and *Platyceras* is purely superficial and regards the Platyceratidae as Aspidobranchia which have adopted a stationary mode of life.

From the Permian rocks of Timor, Wanner (1922 : 11) described 19 different species which he referred to the genus *Capulus*. All of them show fairly close relationships with species from North America, but do not resemble the Australian forms with the exception of one described as ?*Capulus* cf. *tenellus* J. D. Dana. This species was originally described from Lower Permian rocks at Harper's Hill, New South Wales. It is thought that any resemblance to the Australian species is homeomorphic.

Wanner mentioned the difficulty in determining specific characters because of the great variability in the group, a variation in form he thought was due largely to conditions under which the animal lived. This question has been discussed on many occasions by authors, particularly Keyes (1890 : 150). Variation in the form of the shell has been suggested as being influenced by conditions experienced after attachment of the individual.

Wanner states that the many types found in Timor are represented, with few exceptions, by one, or a few individuals.

In a recent most comprehensive and interesting work, Bowsher (1955 : 1—11) discussed the origin and adaptation of the Platyceratid gastropods. He recorded many examples of crinoids with attached shells of *Platyceras* over the crinoid's anal vent. It was found that the irregularities of the apertural margin of the attached shells invariably fitted the irregularities of the tegmen of the host. Bowsher concluded that *Patyceras* possessed a coprophagous habit and that the group had evolved directly from *Naticomema* in late Ordovician or early Silurian times.

The generally accepted fact that the shape of Platyceratid shells is a reflection of their stationary habit cannot be recognised in the species of *Rhabdocantha* from Harper's Hill.

It seems obvious that these shells cannot be regarded as belonging to the genus *Platyceras* as in no instance is there the slightest indication of the apex of the shell being enrolled or in contact. They appear to have certain affinities with some species referred in the past to the genus *Orthonychia* of Hall but the characters cannot be reconciled with those of the type species, *Platyceras* (*Orthonychia*) *subrectum* from the Devonian Upper Heidelberg Limestone of New York, U.S.A. The shells from New South Wales are generally dissimiliar, show little or no signs of irregularity of growth and do not possess any

longitudinal grooves, nodes or spines. Close relationships with *Platyceras* and *Orthonychia* are apparent but as I am of the opinion they cannot be referred with certainty to either genus I have erected the genus *Rhabdocantha* for them. Although the species range from cone-like to a decidedly arcuate shell, they are associated generically by shell structure, form, and ornamentation which are remarkably similar.

The species of *Rhabdocantha* are interesting in that there is a progressive degree of curvature from a cone-like form to a strongly arcuate shell. The problem arises whether the shells are growth stages of the one species or whether certain forms are specifically distinct. The shells are by no means common and with the absence of a large series it is difficult to come to a definite conclusion. It is significant, however, that 4 species are represented in each case by 2 identical shells, 1 species by a single shell, and 1 species by 6 specimens which vary considerably in size but not in form. The single specimen of *Rhabdocantha intermedia*, which might be considered a growth stage of *R. ungula* is found to be entirely dissimilar from a shell of the same dimensions of that species. These facts together with a definite variation of inflation and angle of curvature indicate specific differences and they have been described as such.

In only one, doubtful, instance do the Australian Permian shells of the Platyceratidae show any evidence of a parasitic habit. A specimen of *R. ungula* (F.35586) is attached to a shell of *Keeneia ocula* (Sowerby), covering part of the spire, but although near the aperture, would not have covered it to any great extent. The apertural margin of the shell of *R. ungula* is well preserved. Beyond a slight thickening, however, it is most regular and shows no sign of having followed the outline of the shell to which it is attached. Under the circumstances it would appear that this particular association is a fortuitous one rather than an example of a parasitic coprophagous habit. Most of the shells of *Rhabdocantha* from New South Wales are comparatively large in size and in no instance does the apertural margin show any indication of irregularities due to parasitism.

Rhabdocantha alta Dana

(Pl. 7, figures 1—4.)

Pileopsis alta Dana, 1849; 706; Atlas, pl. ix, figure 14.

Platyceras (*Orthonychia*) *altum* Etheridge, 1896 : 15, pl. i, figures 1—2.

Neotype (here chosen) : Specimen No. F.35587, figured by Etheridge 1896 : pl. i, figure 1. From Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Description.—Shell elongate-arcuate, regularly curved, essentially in the one plane; apex sharply pointed, produced well forward of the apertural margin and slightly twisted to one side. Cros -section of valve at aperture is elliptical; apertural margins not thickened, straight, showing no irregularities of attachment. Valve expanding rapidly and evenly from apex to aperture. Dorsal surface of valve rounded, flanks flattened, ventral surface rounded.

Shell surface smooth, slightly undulated by transverse ridges representing stages of growth. Ornamentation consists of numerous very fine transverse lirae with regularly arranged, interpolated, sharp stronger lirae; closely crowded longitudinal lirae form a subdued cancellate pattern. Lirae indistinctly crenulate. Shell thin. Muscle scars are not visible.

Dimensions.—

	Neotype F. 35587	Plesiotype F.35585
	mm	mm
Height	30	25
Width of aperture	22	19·5
Length of aperture	33	25
Length along curvature from apex to aperture	80	68

Remarks.—This species was originally based on a specimen in the collection of the Rev. Mr. Wilton of Newcastle, from whom it was borrowed and described and figured by Dana (1849 : 706; Atlas, pl. ix, figure 14). Enquiries have not brought any results regarding the present location of this specimen, but as it is now more than a century since it was described it can safely be assumed to be lost. A neotype has therefore been chosen.

Etheridge (1896 : 15) expressed some doubt whether his specimens were conspecific with the small specimen described by Dana, a shell 18 mm in height and with a length of 16 mm along the aperture. I am of the opinion they are, as the curvature of the shells is identical and although the apex of Dana's shell is not bent down to the same extent in his illustration (Dana 1849 : pl. ix, figure 14a), it is mentioned in the text as being " much recurved forward ". The specimens were also collected from the same horizon of the Allandale Formation at Harper's Hill.

Etheridge recorded a specimen of *R. alta* from Rutherford, 3½ miles from West Maitland, in the Hunter Valley. It cannot be traced in the collection of the Mining and Geological Museum. This locality is slightly west of Harper's Hill and it is possible the specimen came from the Rutherford Formation, originally recognised as the shales and sandstones of the upper part of the Allandale Formation.

A single specimen, 5 mm in height, was described and figured by de Koninck (1877 : 180; pl. xxiii, figure 5) as *Platyceras altum* Dana, from rocks of Lower Carboniferous age at Pallal, New South Wales. This specimen which was subsequently destroyed at Sydney in the Garden Palace fire of 1882, was apparently not a typical shell of the species.

Localities and stratigraphical position.—Harper's Hill; Allandale Formation. Rutherford, 3½ miles west of West Maitland; Rutherford Formation, Dalwood (Lower Marine) Group.

Rhabdocantha cornucapella (Etheridge)

(Pl. 7, figures 5—7.)

Platyceras (*Ornthonychia*) *cornucapella* Etheridge, 1896 : 15, pl. 1, figure 3.

Holotype (by monotypy) : Specimen No. F.35588, figured by Etheridge 1896 : pl. 1, figure 3. From Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Remarks.—This species was described very fully by Etheridge who, although stressing several characteristic features, felt that it could possibly be only a variety of *R. alta* (Dana). He was no doubt influenced in this regard by the conclusions put forward by certain authors that Platyceratid shells in other parts of the world adopted individual variation because of their environment and mode of life. There is no evidence that this is the case as far as the shells of *Rhabdocantha* are concerned and as mentioned earlier in this paper there is no indication of any considerable individual variation within a species.

In general form the shell of *R. cornucapella* is rather similar to those of *R. alta*. It is readily distinguished, however, in its degree of curvature, by being less elongate, more compressed laterally and by the narrowly rounded dorsal surface. The apex is produced beyond the apertural margin and even though the point is missing could not have been nearly as incurved as in *R. alta*. The expansion or tapering of the valve from the aperture to the apex is gradual. Aperture elongate-elliptical.

The surface of the shell is produced into fairly regular concentric undulations, well defined and distinct from the ornamentation which consists of microscopic transverse, crenulate lirae. These are crossed by similar longitudinal lirae and thus form a subdued cancellate pattern.

A second specimen of this species was recently collected from the Ulladulla Mudstone at Ulladulla. There is some doubt regarding its actual locality, but if the record is correct it is the first specimen of the genus from rocks younger than the Dalwood (Lower Marine) Group. The specimen agrees very well with the holotype.

Dimensions.—

	Holotype mm
Height	21·5
Width of aperture	13
Length of aperture	22
Length along curvature from apex to margin of aperture	47

Locality and stratigraphical position.—Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Rhabdocantha adunca sp. nov.

(Pl. 7, figures 8—9.)

Holotype.—Specimen No. F.46400 from Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Paratype.—Specimen No. F.46401, from same locality and horizon.

Description.—Shell elongate, strongly arcuate; apex sharply pointed, very much incurved and almost in contact with the shell at the anterior apertural margin; not enrolled but slightly twisted to one side. Degree of expansion is rapid from apex to aperture of shell; two-thirds of shell laterally compressed, markedly inflated near and at the aperture. Aperture elliptical in outline, margins or peristome straight, regular, with no sinuations. Dorsal surface of shell very narrowly rounded, evenly curved longitudinally; elongate; ventral margin restricted, short, forming a small almost complete circle.

Surface marked by regular concentric undulations. Ornamentation consists of well defined, longitudinal crenulate lirae, crossed by less defined and less numerous concentric lirae.

Dimensions.—

	Holotype mm
Height	32
Length of aperture	32
Width of aperture	22
Length along curvature from apex to margin of aperture	86

Remarks.—This outstanding and easily recognised species is represented by two specimens. The holotype is a well preserved shell with portion of the original shell and ornamentation still attached. The paratype is incomplete and is practically a steinkern. The characteristic features of the species are its very arcuate form, lateral compression, and extreme inflation at the aperture.

Locality and stratigraphical position.—Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Rhabdocantha intermedia sp. nov.

(Pl. 7, figures 10—11.)

Holotype.—Specimen No. F.26950, from Allandale, near Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Description.—Shell elongate-conical, somewhat arcuate, expanding rapidly from the apex and attaining maximum inflation at the aperture; apex obtuse, not projecting beyond the apertural margin, not incurved, slightly twisted to one side. Dorsal margin of shell broadly and evenly convex; ventral margin sloping inwards from margin in a wide curve to the apex. Aperture elongate-oval with regular and straight margins.

Surface of shell marked by occasional transverse undulations representing growth stages. Ornamentation consists of numerous, fine longitudinal lirae, crossed by indistinct transverse almost microscopic lirae. Shell substance thin.

Dimensions.—

	Holotype mm
Height	48
Width of aperture	21
Length of aperture	27
Length along curvature from apex to apertural margin	45

Remarks.—This species, represented by a single well preserved specimen, may be considered as an intermediate form which links the more elongate and arcuate species of *Rhabdocantha* with the conical shells of *R. ungula*. It would appear to be a more adult and therefore more elongate form of the former species, but this is not the case as a shell of *R. ungula* of approximately the same dimensions retains the distinctive features of that species. The shell of *R. intermedia* is distinguished from those of the foregoing species by its more conical form, the apex situated within the marginal limits, and the aperture, faintly campanulate, is more oval in outline than elliptical. As mentioned previously the ornamentation in all the species of *Rhabdocantha* is very similar.

Locality and stratigraphical position.—Allandale near Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Rhabdocantha ungula (Etheridge)

(Pl. 7, figure 12; pl. 8, figures 1—3; pl. 9, figures 3—4.)

Platyceras (*Orthonychia*) *ungula* Etheridge, 1898: 16, pl. i, figure 4.

Holotype (by monotypy): Specimen No. F.35586, figured by Etheridge 1898: pl. i, figure 4. From Harper's Hill, Dalwood (Lower Marine) Group.

Remarks.—As pointed out by Etheridge (1898 : 16) in his very complete description of this species it includes shells which are conical in form and not produced posteriorly in the form of an arc. The apex is blunt, not incurved and is restricted within the marginal limits of the shell. The dorsal margin of the shell is slightly curved while the ventral margin is straight to slightly concave; evenly inflated with sides slightly convex, not flattened; aperture oval, slightly longer than wide, with a straight and regular, non-sinuate, peristome.

Dimensions.—

	Holotype mm	F.46402 mm
Height	19	26
Length of aperture	20	27
Width of aperture	17	25†
Length along curvature from apex to margin of aperture	23	29

† Estimated width as specimen is flattened on one side due to pressure during preservation.

This particular species has very few definite characters to distinguish it from conical shells of similar form described from widespread localities and various stratigraphical formations.

Dana (1847 : 151) briefly described a small conical shell from Harper's Hill as *Patella tenella*. Two years later (1849 : 706) he referred it to the genus *Pileopsis* with the following description : " Short, conical, oblong, acuminate at apex, and very narrowly recurved. Apex anterior to centre, but situated over the base; aperture ovate-elliptical, entire, half narrower anteriorly. Surface smooth. Length of aperture $\frac{8}{8}$th of an in; breadth $\frac{8}{8}$th of an in; height of cone same as breadth."

Etheridge (1898 : 15) held the opinion that this specimen is an abnormally depressed form and considered it was distinct from *R. ungula*. The dimensions and form, with the exception of the curved anterior margin, are not dissimilar from shells of that species. An examination of a plastotype of the specimen figured by Dana indicates that the apex has been damaged to some extent during preservation. The apical portion has been forced forward and to one side and if this proves to be the case the shell would agree very well with *R. ungula*. It is possible that Dana's figure (1849 : pl. ix, figures 13a, b), has been idealised to some extent. An examination of the type material in the collection of the United States National Museum, Washington, would no doubt determine whether the two forms are conspecific.

A very small specimen, height 6 mm and length 8 mm, from Carboniferous rocks at Colocolo, was described by de Koninck (1877 : 319) as *Platyceras tenella* Dana. Its relationships are impossible to determine from the description and figure, but it almost certainly differs from that species. De Koninck himself stated that the specimen, together with that of *P. alta*, could be young individuals of an unknown species. The specimens were subsequently destroyed in the Garden Palace fire of 1882, in Sydney.

From the Permian rocks of Timor, Wanner (1922 : 55; pl. clii, figure 22) described and figured a conical form of shell as *?Capulus* cf. *tenellus* Dana. It bears a superficial resemblance to Dana's species from New South Wales, but with conical shells of this type I consider that, with shells so geographically distinct, any similarity is homeomorphic.

In the series of specimens of *R. ungula* from Harper's Hill there is considerable variation in the size of the shells, but not in form and the distinguishing characters are constant.

Locality and stratigraphical position.—Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Rhabdocantha irregularis sp. nov.

(Pl. 8, figures 4—5; pl. 9, figures 1—2.)

Holotype : Specimen No. F.27525, from Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Description.—Shell moderately arcuate, subconical not produced posteriorly; depressed; apex sharply pointed very slightly bent downwards, twisted to one side, not extending to any great extent beyond the apertural limits. Aperture somewhat ovoid, wide below the apex and narrowing anteriorly. Expansion of shell increasing rapidly from apex to the aperture, slightly asymmetrical causing a slight twist to the dorsal surface which is sharply rounded; flanks flattened, greatest inflation and width posteriorly.

Surface marked by regular transverse undulations of growth. Ornamentation consists of fine almost microscopic transverse lirae, cancellated by similar type of longitudinal lirae.

Dimensions.—

	Holotype mm
Height	21
Length of aperture	38
Width of aperture	27
Length along curvature of dorsum	57

Remarks.—This outstanding and interesting species is represented by only two specimens from the Allandale Formation at Harper's Hill. The twisted nature of the shell, due to asymmetrical growth is exhibited in both specimens and almost certainly is not caused by pressure and distortion. It is readily distinguished from *R. ungula* by the curved dorsum and the downwardly produced apex; it is a characteristic species, but has similar ornamentation to other species of the genus.

Locality and stratigraphical position.—Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Genus **Platyceras** Conrad 1840.

Type Species, by subsequent designation of Knight 1934 : 147, *Pileopsis vetusta* Sowerby 1829.

Remarks.—As mentioned earlier in this paper the characteristic features of the genus consist of shells with earlier whorls coiled, in contact, and the last whorl free and expanded.

Two very poorly preserved specimens in the collection of the Australian Museum from the Dalwoood (Lower Marine) Group, have been referred to the genus *Platyceras*. One specimen, F.46403, from the Allandale Formation at Allandale, is somewhat similar to shells of *Rhabdocantha adunca* in that it is strongly arcuate and depressed sub-conical in form. It differs however, markedly, in that the extreme apical portion is enrolled to form a small volution which is in contact, joining the body whorl slightly above the posterior extremity of the aperture. The specimen is not sufficiently preserved and is too incomplete for description. It is mentioned only as a record of the genus *Platyceras* in the Allandale Formation.

The second specimen, F. 30004, is from the Ravensfield Sandstone at the base of the Farley Formation. It is a complete shell and is not conspecific with the Allandale specimen, differing in the length and shape of the aperture. The small whorl is barely elevated and does not rise above the plane of the large expanded body whorl. In the Silurian rocks of the Yass district, several undescribed species agree with the characters of the genus *Platyceras* Conrad 1840. These shells possess a fairly close relationship with *P. farleyensis* sp. nov., from the Permian rocks of the Hunter River Valley.

Platyceras farleyensis sp. nov.

(Pl. 8, figure 6.)

Holotype : Specimen No. F.30004, from the Ravensfield Quarry, near Farley. Ravensfield Sandstone, Farley Formation, Dalwood (Lower Marine) Group.

Description.—Shell of comparatively small size, obliquely horn-shaped of about two whorls, the last greatly expanded dorso-ventrally, broadly curved; apical portion twisted, extremity coiled to form a small volution contiguous with body whorl slightly above posterior apertural margin; last or body whorl rapidly expanding to the aperture, compressed, only slightly inflated; peristome regular with a possible slight anterior sinus. Dorsal surface sharply rounded, almost angulate posteriorly, widening and more rounded towards aperture; apex depressed below the plane of the body whorl; shape of aperture unknown, but narrow; surface of shell with faint concentric undulations of growth; ornamentation not preserved.

Dimensions.—

	mm
Height	15
Length along curvature from apex to aperture	39
Total width	23
Breadth	11

Remarks.—The species is represented by a single specimen which is not sufficiently preserved to reveal any traces of ornamentation or distinct features of the aperture. The peristome shows an indication of a sinus, a doubtful character however, which may be the result of weathering. The aperture is not campanulate.

This species is intermediate between the horn-shaped shells of *Rhabdocantha* and the apically coiled shells of *Strotostoma* gen. nov. The three genera, *Rhabdocantha* gen. nov., *Platyceras* Conrad, and *Strotostoma* gen. nov., could possibly be evolutionary phases within the Platyceratidae. The shells of *Strotostoma*, found in the higher formations of the Maitland (Upper Marine) Group attained considerable size.

The single shell of *Platyceras farleyensis* appears to me to be the only one from the Permian of New South Wales which agrees with the accepted characters of the genus as defined by J. Brookes Knight. Its strongest affinities are not with *P. vetusta* (Sowerby), the type species of the genus, but more with species in which the shells are arcuate, such as those described by Hall (1859 : 311, figures 1—2 on p. 310), as *P. ventricosum*. Both are broadly curved forms in which the small volution merges into

and is contiguous with the body whorl near the posterior apertural margin. The coiling however, in *P. farleyensis* is less pronounced and the aperture is not campanulate. The species is described from a single specimen, so that this type of gastropod would be recorded as occurring in the Permian rocks of New South Wales.

Locality and stratigraphical position.—Ravensfield Quarry, near Farley. Ravensfield Sandstone, base of Farley Formation, Dalwood (Lower Marine) Group.

Genus **Strotostoma** nov.

(*Strotos*, spread; *stoma*, mouth.)

Type Species: *Strotostoma rylstonensis* sp. nov.

Generic Description.—Moderately large naticiform gastropods, transversely produced with a small, low spire and large inflated body whorl; base extended; three to three and a half whorls; whorl profile broadly arched, somewhat flattened above and below; sutures deep. Aperture large, sub-oval to oval; false umbilicus; surface with well defined spiral and transverse costae. Shell thin.

Remarks.—A series of 25 specimens of species placed in this genus has been collected from three localities in rocks of the higher formations of the Maitland (Upper Marine) Group and its equivalents. The material is mainly from about 2 miles north-west of Rylstone (Western coalfield); five specimens are from Gerringong (Illawarra district) and a single specimen is from Congewai, near Cessnock (Hunter River Valley). The material is not particularly well preserved and in no instance has an aperture with its complete peristome been preserved.

The shells are outstanding forms as far as the Permian gastropod fauna of New South Wales is concerned and two species are represented.

There is no doubt in my opinion regarding the relationship of these shells with those of the Platyceratidae. They bear a close resemblance to a single shell described and figured by Waagen (1880: 105) as *Platystoma indicum* from the Permian of the Salt Range, India. In fact it is possible that the two forms may prove to be congeneric. Waagen apparently was doubtful regarding the correct classification of his shell, but finally referred it to the genus *Platyostoma* (corrected spelling).

The holotype of *Platyostoma ventricosa* Conrad, the type species of the genus *Platyostoma* Conrad (1842: 275) was re-described in detail and figured by Brookes Knight (1941: 253). It bears little relation to *Strotostoma* as it is a distinct naticiform type of gastropod with strongly rounded whorls and a closely coiled body whorl.

Grabau (1931: 359) in describing Waagen's species of *Platystoma indicum* from the Permian of Mongolia, referred it to the genus *Strophostylus* Hall, 1859, (type species *S. andrewsi* Hall). Some of the features of *Strotostoma* bear a close resemblance to those of *Strophostylus*, but an important character of that genus is a " strongly developed, twisted, platelike fold in the columella ". This is not present in the Australian shells and apparently is also absent in both the Indian and Mongolian species.

It seems impossible to reconcile the Australian shells to either of the above genera with any degree of certainty. Both *Platyostoma* and *Strophostylus* are also more characteristic of middle Palaeozoic rocks rather than late Permian.

Strotostoma rylstonensis sp. nov.

(Pl. 8, figures 7—11; pl. 9, figure 5.)

Capulus sp. indet. Laseron 1910: 221.

Holotype: Specimen No. F. 40940, from about 2 miles north-west of Rylstone. Base of Capertee (Upper Marine) Group.

Paratypes: Specimens No. F.39682 and F.45392, same locality and horizon.

Description.—Moderately explanate gastropods with a small low spire and a greatly enlarged body whorl forming the greater part of the shell. Body whorl increases rapidly in size spreading outwards and downwards and extending the base of the shell. Three to three and a half whorls; whorl profile broadly rounded, flattened on the upper half and flatly arched on the lower half. Sutures between whorls deep. A false umbilicus is developed. Aperture large, oval and obliquely distended; peristome thin. Columella lip straight, slightly thickened and reflected back; lower lip sharply bent at its junction with the columella lip, then flatly curved to merge uninterruptedly with the broadly downward curved outer lip.

Ornamentation consists of numerous fairly coarse spiral costae and finer transverse costae forming a lattice structure.

Dimensions.—

	Holotype F.40940	Paratypes F.39682	F.45392
Height	36 mm	40 mm	33 mm
Breadth	42 mm	52 mm	43 mm
Breadth of aperture	...	29 mm	...
Apical angle	142°	138°	142°

Remarks.—As mentioned earlier this species is a characteristic one and with perhaps the exception of *Strotostoma inflata* sp. nov. cannot be confused with any other Permian gastropods from New South Wales. The small spire, greatly enlarged and obliquely distended body whorl, and characteristic ornamentation make it an outstanding species.

Most of the specimens were collected from the Capertee Formation near Rylstone and they show a considerable variation in size. One small specimen (F.39628), slightly crushed, has a height of 26 mm and a breadth of 24 mm. A series of five small specimens, from the Westly Park Tuff at Gerringong, approximately 22 mm in height and 25 mm in breadth, almost certainly belong to this species. They agree perfectly in most characters and they possess the characteristic ornamentation. A single, incomplete specimen (F.39859), from an unspecified locality near Congewai, near Cessnock, could belong to either the Muree or Mulbring Formations, and is also a typical example of the species. This species therefore has a fairly wide horizontal distribution while stratigraphically its vertical range is very small as in all probability most of the formations in which it occurs will prove to be correlatives.

The well defined ornamentation as shown on an exceptionally well preserved portion of specimen No. F.39625 (pl. 8, figure 8), is not exhibited to the same extent on all specimens. In most cases weathering has considerably subdued the ornamentation pattern, but nevertheless the spiral and transverse costae are usually visible.

The single specimen described by Waagen (1880 : 105), as *Platystoma indicum* from the upper region of the middle division of the Productus-limestone of India, bears a very strong resemblance to *Strotostoma rylstonensis* sp. nov. Waagen however, mentions a thickened inner lip which is not present on the Australian shells and it is doubtful whether the ornamentation is similar. In *S. rylstonensis*, even on badly weathered specimens, the strong spiral costae are a strong feature.

Localities and stratigraphical position.—Two miles north-west of Rylstone; base of Capertee (Upper Marine) Group. Gerringong; Westley Park Tuff, Gerringong (Upper Marine) Volcanics, Burrier; Wandrawandion Formation, Shoalhaven (Upper Marine) Group. Congewai, near Cessnock; Muree or Mulbring Formations, Maitland (Upper Marine) Group.

Strotostoma inflata sp. nov.

(Pl. 9, figures 6—8.)

Holotype : Specimen No. F.45350, from about 2 miles north-west of Rylstone. Base of Capertee Group.

Paratype : Specimen No. F.44246, same locality and horizon.

Description.—Moderately large, sub-globular gastropods with a low, distinct, small spire and large inflated body whorl; base extended on the apertural (right side) of shell. Three to four whorls, those on the spire small and closely coiled, expanding rapidly to form a very large body whorl which forms the greatest bulk. Whorl profile rounded, sutures well pronounced. Aperture oval, peristome thin with no apparent thickening of the columella lip. Well defined transverse growth ridges developed on body whorl. Ornamentation consists of spiral ribbing with possible transverse costae.

Dimensions.—

	Holotype F.45350	Paratype F.44246
Height	44 mm ‡	53 mm
Breadth	56 mm	49 mm
Breadth of aperture	...	33 mm
Height of aperture	...	33 mm
Apical angle	116°	103°

‡ Specimen slightly distorted.

Remarks.—This species is represented by seven rather poorly preserved specimens in which the apertural characters are to a great extent missing. The ornamentation is not preserved except for traces of coarse spiral costae on the spire of the holotype. The species, however, is so closely related to *S. rylstonensis* sp. nov., with which it is associated, that in all probability the type of ornamentation is similar. It is readily separated from that species by its more inflated whorls, a more erect and distinct spire, and the development of definite growth ridges on the body whorl, a feature which appears to be constant.

Locality and stratigraphical position.—Two miles north-west of Rylstone; conglomerate at base of the Capertee (Upper Marine) Group.

Super-Family **Pleurotomariacea.**

Family **Pleurotomariidae.**

Genus **Mourlonopsis** nov.

Type Species : *Pleurotomaria strzeleckiana* Morris.

Generic Description.—Medium sized turbinate pleurotomarids with a moderately high spire, five to six distinct, rounded whorls, slightly shouldered close to the upper suture; a narrow selenizone bordered by carinae, situated above the whorl periphery; sutures sharply angular and deep; base rounded, phaneromphalous; outer lip with a wide insinuation, culminating in a short slit; aperture elongate-oval, its vertical plane sloping inwards at about 35°; columella lip thick, somewhat flattened, arcuate and to some extent reflexed; ornamentation consists of striae following the line of growth and possible fine spiral lirae. Shell thin.

Discussion.—This genus is introduced for the species *Pleurotomaria strzeleckiana* described by Morris (1845 : 287) as it has been pointed out by Knight (1941 : 21) that the genus *Pleurotomaria* (genotype *Pleurotomaria similis* Sowerby 1816), constitutes a Jurassic group of shells with little or no resemblance to Palaeozoic species.

The genus *Mourlonopsis* bears some resemblance to *Platyteichum*, a genus introduced by Campbell (1953 : 23) for turbinate gastropods from the Permian of Queensland. Marked features in that genus, which are not found in *Mourlonopsis*, include the flat upper whorl surfaces; the whorls overlap to the base of the slit-band which forms the whorl periphery.

Among other related genera, *Mourlonia* of de Koninck 1883 (genotype *Helix carinatus* Sowerby 1812), appears to be somewhat similar. *Mourlonopsis* is differentiated however, by a more erect spire with a smaller body whorl and an even decrease in the size of the whorls, the pleural angle being 71° The whorls are not at all impressed over the adjoining ones, but are closely separated by deep, slightly angular sutures. The narrow selenizone is situated above the periphery of the whorls and well above the lower suture.

Mourlonopsis has no close relationship with species such as *Pleurotomaria morrisiana* M'Coy, which in this paper are referred to the genus *Pleurocinctosa* nov. Campbell (1953 : 24) correctly concluded that his genus *Platyteichum* is not congeneric with that group.

Mourlonopsis strzeleckiana (Morris)

(Pl. 9, figures 9—11.)

Pleurotomaria strzeleckiana Morris, 1845 : 287, pl. xviii, figure 5.

Pleurotomaria strzeleckiana M'Coy, 1847 : 306.

Pleurotomaria strzeleckiana Dana, 1849 : 707.

Pleurotomaria strzeleckiana Plews, 1858 : pl. iii, figure 4.

?*Mourlonia strzeleckiana* Etheridge, 1892 : 287, pl. xv, figure 2.

Mourlonia strzeleckiana Laseron, 1910 : 221.

Holotype : (by monotypy) : Specimen figured by Morris 1845 : pl. xviii, fig. 5, in the collection of the British Museum.

Description.—Medium sized pleurotomarids with a moderately high spire, five and occasionally six whorls, base rounded, phaneromphalous; whorl profile rounded, slightly shouldered close to upper suture; whorls not overlapping the previous ones but clearly separated by deep, slightly angular sutures; an even decrease in the size of the whorls; outer lip with a wide insinuation culminating in a short slit which gives rise to a well defined, narrow selenizone bordered with indistinct carinae, and situated above the whorl periphery; outer lip much longer below the selenizone than above it; umbilicus moderately deep and narrow; aperture elongate-oval, its vertical plane sloping inwards at about 35°; columella lip straight, arcuate vertically, flatly rounded, slightly reflected and wider at its junction with the penultimate whorl and the outer lip; shell thin.

Ornamentation of growth lines paralleling outer lip; indications of spiral ridges.

Dimensions.—

	F.46579	F.21762	F.21255
Height	35 mm	46 mm	45 mm
Width	31 mm	41 mm	39 mm
Pleural angle	71°	71°	73°
Height of aperture	...	...	22 mm
Width of aperture	...	...	19 mm

Remarks.—This species is very abundant in the Gerringong Volcanics and Shoalhaven Group (Upper Marine Series) of the South Coast, particularly at Wollongong and Gerringong. It is also known from other localities including Rylstone (Western Coalfield) and Glendon (Hunter River Valley). It is not known from the Dalwood (Lower Marine) Group or its equivalents.

The species was originally described and figured by Morris (1845 : 287) as *Pleurotomaria strzeleckiana* and was recorded as being abundant at Glendon and Illawarra (Wollongong and Gerringong). The illustration of his specimen (1845 : pl. xviii, figure 5), the holotype, is the only one in which I have observed the complete margin of the outer lip, the wide insinuation and short slit. The illustration may be idealised to some extent, as Campbell (1953 : 24) states that the specimen is a steinkern with small traces of shell in the sutures and the umbilical region. In a large series of more than seventy specimens there is not one specimen on which the original shell material has been completely preserved On several specimens small portions of the very thin shell indicate the presence of spiral ribbing above and below the selenizone. In steinkerns the selenizone is preserved as a narrow ridge, bordered by shallow sulcations.

M'Coy (1847 : 306) simply listed *Pleurotomaria strzeleckiana* Morris as being common in the fine calcareous grits at Wollongong, while Dana (1849 : 707), stated the species was abundant in the Illawarra Sandstone, but no Glendon or Harper's Hill specimens were met with. A specimen illustrated by Plews (1858 : plan iv) as *Pleurotomaria strzeleckiana* Morris, with no comments, is a typical example of the species.

Etheridge (1892 : 287) was of the opinion that the species should be referred to the genus *Mourlonia*. He described and figured a specimen as *Mourlonia strzeleckiana* (Morris), from the Gympie beds, near Rockhampton, Queensland, although he mentioned it was a more inflated form than the typical species. Some of the shells from New South Wales attain the same length as the Queensland form and possess equally inflated whorls. I have been unable to examine any specimens from Queensland and for the present its status must remain doubtful, although it appears they are not conspecific.

The shells of *Mourlonopsis strzeleckiana* (Morris) are characterised by the moderately high spire, the development of a selenizone, and very rounded whorls. The only other species it even remotely resembles in the Permian of New South Wales is *Pleurocinctosa trifilata* (Dana) which is much smaller in size and has an entirely different whorl profile. *Platyteichum costatum* Campbell, differs from *M. strzeleckiana* (Morris) in being smaller in size, with a flattened profile on the upper half of the whorl; the sutures are much less pronounced and the whorls overlap to the base of the slit-band.

Localities and stratigraphical positions.—Wollongong, Gerringong, Kiama, (Gerringong Volcanics); Kioloa, Burrier, Ulladulla, Wyro, near Ulladulla, Jervis Bay, (Shoalhaven Group); Rylstone, (Capertee Group); Maitland, (? Mulbring Formation); Glendon, (? Belford Formation, Maitland Group).

Genus **Cycloscena** nov.

(*Kuklos*, circle; *scene*, tent.)

Type Species : *Cycloscena anomphala* sp. nov.

Description.—Moderately large, sub-trochiform, anomphalous, gastropods; five whorls with a slight keel on the periphery of the body whorl and a less defined carina slightly superior to it; whorl profile between sutures gently arched; periphery sub-angulate to rounded; base moderately convex, sutures fine, almost linear; ornamentation numerous fine lirae and growth lines. Aperture sub-circular; shell moderately thick; columella lip thick, flattened.

Remarks.—This genus is a unique form in the Permian gastropod fauna of Australia, characterised by being distinctly anomphalous, its broadly conical form, the thickly developed and broad, flattened columella lip, and the fine and abundant lirae of the ornamentation.

The genus bears a striking resemblance to the genus *Mourlonia* Koninck 1812 (Genotype *Helix carinatus* J. Sowerby 1812) and particularly to a large specimen (PG.40) in the British Museum collection, and figured by Knight (1941 : pl. xxix, figure 1b). It differs, however, from members of that genus in not possessing a defined selenizone, in the adpressed development of the upper whorls, and also the absence of any revolving striae.

It differs from *Gosseletinia* Fischer 1885, (Genotype *Pleurotomaria callosa* Koninck 1843), in its more conical form, steeply arched body whorl and a keel developed on the periphery, whereas in *Gosseletinia* a well defined selenizone is developed high on the whorls.

The genus is represented by the single species, *C. anomphala* sp. nov.

Cycloscena anomphala sp. nov.

(Pl. 10, figures 1—3).

Holotype: Specimen No. 29777. Allandale Formation, Dalwood (Lower Marine) Group; Allandale, Hunter River Valley.

Paratype: Specimen No. F.46586, same horizon and locality.

Description.—Large broadly conical, sub-turbinate, anomphalous gastropods with five whorls; apex erect, pointed; an ill-defined carina on the periphery of the body whorl with an even less defined second carina slightly superior to it; body whorl moderatley extended transversely; upper margins of whorls slightly extended vertically and closely pressed on to previous whorls; a narrow sulcus is developed near the upper margins of the whorls; profile of apical whorls steeply sloping, gently arched; body whorl broadly arched; periphery narrowly rounded almost carinate at penultimate whorl; base flatly convex; sutures fine, almost linear; outer lip seemingly directed obliquely backwards, without sinus; columella lip thick, wide and flattened, merging with the base; aperture sub-circular. Ornamentation sharp, numerous lirae, 18—20 in 5 mm, with occasional heavy growth lines, directed obliquely backwards, increasing in obliquity near the periphery where a slight angle is formed as the lirae cross and extend almost straight across the base. Shell thick at upper suture thinning towards periphery, lower inner lip and columella lip thick.

Dimensions.—

	Holotype F.29777	Paratype F.46586
Height	63 mm	69 mm
Width	80 mm	83 mm
Pleural angle	100°	100°

Remarks.—This very outstanding species is represented by four specimens from the type locality at Harper's Hill. Its characteristic features have already been outlined in remarks on the genus. In no instance has the peristome been preserved and the presence of a sinus of any description on the outer lip is doubtful. The ridge or keel developed on the periphery and the ill-defined carina above it cannot be regarded as defining a selenizone and are in all probability ridges formed by a thickening of the shell on the outer lip. Removal of the shell by weathering, particularly the thickened portion at the sutures, reveals the steinkerns to be very broadly rounded on the body whorl with a wide and deep space at the suture.

Locality and stratigraphical position.—Harper's Hill, near Allandale, Allandale Formation. Dalwood (Lower Marine) Group.

Genus **Keeneia** Etheridge 1902.

Type Species: By original designation, *Keeneia platyschismoides* Etheridge, 1902: 198.

Description.—Very large trochiform, narrowly phaneromphalous gastropods with a narrow insinuation in the outer lip; profile of whorls (four to five in number), shouldered below upper suture, flattened to slightly convex, sloping outwards; periphery of body whorl angulate to sharply rounded; base flatly arched; sutures shallow. Aperture large, obliquely quadrangular. Columella lip thickened, parietal inductura thin to moderately thick. Ornamentation sharp, fine transverse lirae, resembling a false selenizone on the whorl periphery.

Remarks.—This is an outstanding genus and is characterised by its large size, strongly shouldered and almost flat sloping whorl profile, and the development of a pseudoselenizone on the angulate, almost carinate, periphery of the body whorl.

Dana (1849: 707, pl. x, figure 1) described and poorly figured a specimen from Harper's Hill as *Platyschisma oculus* (Sowerby). Etheridge (1902: 199) was of the opinion that this specimen "has every appearance of a peculiarly drawn example of *Keeneia platyschismoides*". An examination of a plastotype of this specimen leaves no doubt that it is the species suggested by Etheridge.

Etheridge (1902 : 199) in his observations on his species, *K. platyschismoides*, suggested that *Platyschisma depressum* Dana was a second species of his genus *Keeneia*. This assumption at the time was to some extent correct, but in my opinion a group of forms with depressed shells after the type of *P. depressum* Dana are so dissimilar to the type species of *Keeneia* that they warrant distinct generic rank. The genus *Planikeeneia* has been erected for these shells.

The single shell from the type locality of *P. depressum* Dana, and described by Mitchell (1923 : 278) as *Platyschisma allandalensis* is conspecific with the former species and has been placed as a synonym of it.

Etheridge (1902 : 199) was also of the opinion that what he had considered in 1898 (p. 176, pl. xix, figures 14—17) as a specimen of *Platyschisma oculus* (Sowerby), was really a young individual of *Keeneia platyschismoides*. This beautifully preserved specimen, an adult shell, together with additional material is almost certainly a distinct species and has been described as *Planikeeneia minor* sp. nov.

Johnston (1888 : pl. xviii, figure 4) figured, but did not describe, a specimen from the Permian of Tasmania as *Plastyschisma ocula* (Sowerby). From the illustration it has a close resemblance to *Keeneia trochiforme* sp. nov. and has been tentatively placed as a synonym of that species. The specimen has been mislaid in the collection of the Tasmanian Museum, Hobart.

Branson (1948 : 702) following the advice of Brookes Knight (personal communication) referred *Platyschisma ocula* (Sowerby), to the genus *Keeneia* Etheridge 1902, and also placed *Keeneia platyschismoides* Etheridge as a synonym of that species. It is considered that *Platyschisma oculus* (Sowerby) should possibly be referred to the genus *Keeneia*, but it is a distinct species and quite unlike *Keeneia platyschismoides*.

Etheridge (1902 : 198) considered that *Platyschisma oculus* (Sowerby) was generically distinct from his genus *Keeneia* and quoted points of difference which are referred to later in this paper in the discussion of the species. These differences could perhaps be taken as only of specific value and following the example of Branson and Brookes Knight it has been referred to the genus *Keeneia*. The large series of specimens of both *Keeneia platyschismoides* Etheridge and *Keeneia ocula* (Sowerby), as shown later in this paper, prove conclusively in my opinion that they cannot be considered as being conspecific.

Keeneia platyschismoides Etheridge.

(Pl. 14, figures 1—2; pl. 15, figures 1—2.)

Platyschisma oculus Dana (non Sowerby), 1849 : 707, pl. x, figure 1.

Keeneia platyschismoides Etheridge, 1902 : 198, pl. xxii, figures 1—2; pl. xxiii, figure 3. (non figures 4—5).

Holotype : By subsequent designation of Brookes Knight (1941 : 163), specimen No. F.7257. figured by Etheridge 1902 : pl. xxxii, figure 2. From Harper's Hill, Allandale Formation, Dalwood (Lower Marine) Group.

Paratype : Specimen No. F.7258, same locality and horizon, figured by Etheridge 1902 : pl. xxxii, figure 1.

Description.—Shell large, trochiform, much wider than high, narrowly phaneromphalous; spire of four to five whorls, moderately depressed; body whorl large, sutures shallow. Whorl profile, well shouldered below the upper suture, flattened to gently convex on the sloping (35° — 40°) sides to the periphery; flattened to gently convex from the periphery to the umbilicus. Periphery sharply angulate becoming sub-angular nearing and at the aperture; aperture large, obliquely quadrangular. Columella lip almost straight, thickened, reflected slightly over the umbilicus; parietal inductura thin; lower lip sharply curved at its junction with the columella lip, almost straight to the angulate periphery; outer lip with a narrow insinuation developed at the periphery of the whorl, not a notch or slit, culminating in a pseudo-selenizone; base of shell flattened becoming arched towards the aperture. Shell thick of two definite layers, an outer thick layer and an inner thin layer.

Ornamentation consists of fairly coarse transverse lirae, usually about five in 5 mm, directed obliquely backwards on the upper half of the whorls; a sharp backward U-shaped bend at the periphery forms a band or false selenizone. On the lower half of the whorls the lirae extend forwards in a faint sigmoidal curve and are gathered together as they enter the umbilicus.

Dimensions.—

	Holotype F.7257	Paratype F.7258	Topotype F.19006
Height	90 mm	85 mm	86 mm
Width	120 mm	122 mm	124 mm
Pleural angle	95°	98°	95°
Length of aperture	65 mm	...	67 mm
Width of aperture	46 mm	...	48 mm

Remarks.—This species was fully described by Etheridge (1902 : 199) and later by Brookes Knight (1941 : 164), when he selected as the holotype a specimen (F.7257) in the Australian Museum collection and figured by Etheridge (1902 : pl. xxxii, figure 2). This specimen was forwarded to Brookes Knight on loan as the only type material of the species which could be found at that time. In the meantime the other specimen (F.7258) figured by Etheridge (pl. xxxii, figure 1) was found. It would appear that Etheridge inferred that the holotype was specimen F.7258, as in his explanation of the plate he stated that Figure 2 is " another specimen " and again on Pl. xxxiii, that Figure 5 is " yet another example ". He thus inferred that the specimen figured on Pl. xxxii, Figure 1, was the holotype. Furthermore it is a well preserved specimen with a complete shell, whereas several of the most apical whorls are missing in the specimen selected as holotype by Brookes Knight. The illustrations figured by Etheridge (1902 : pl. xxxiii, figures 4—5), showing an enlargement of the peripheral bands are not typical shells of *Keeneia platyschismoides.*

The species, *K. platyschismoides,* is represented in the collection by more than thirty large and fairly well preserved specimens from the Allandale Formation at Harper's Hill. It is an outstanding species and is readily recognised from *K. trochiforme* and *K. ocula* by its larger size, much greater width than height, and the presence of a well defined shoulder on the upper part of the whorls.

Etheridge (1902 : p. 199) pointed out that the specimen described and figured as *Platyschisma oculus* (Sowerby) by Dana (1849 : 707), could be conspecific with *Keeneia platyschismoides.* An examination of a plastotype of Dana's specimen proves that his illustration (Atlas, pl. x, figure 1) is a very poor and misleading one and gives no indication of its true features. The specimen actually shows little or no distortion and is a typical example of *K. platyschismoides.* Furthermore it came from the type locality at Harper's Hill. Dana (p. 707) described the specimen as " somewhat rounded conical, the large spire a little depressed, and the angle of the spire about 90° ". The greatest diameter of any specimen in his possession was 3½ inches and the figured specimen he thought represented a depressed specimen, believed to be of this species, *Platyschisma oculus* (Sowerby); " it was probably distorted by pressure ".

Localities and stratigraphical position.—Harper's Hill (type locality); Allandale; Duguid's Hill. Allandale Formation, Dalwood (Lower Marine) Group.

Keeneia trochiforme sp. nov.

(Pl. 10, figures 4—6; pl. 11, figures 1—2.)

Holotype: Specimen No. F.46571, from Harper's Hill, near Maitland; Allandale Formation, Dalwood (Lower Marine) Group.

Paratype: Specimen No. F. 46572, same locality and horizon.

Description.—Large trochiform, narrowly phaneromphalous gastropods with a flatly convex base, aperture vertically produced; whorls five; whorl profile, very slightly shouldered at the upper suture, flat steeply sloping sides to the angulate periphery; sutures shallow, Umbilicus narrow, covered to some extent by the columellar lip which is thickened at its junction with the penultimate whorl. Parietal inductura thin. Ornamentation consists of fairly coarse lirae, numerous and directed backwards on the upper half of the whorls; at the periphery the lirae sweep acutely back, then forward again to form a false selenizone or band; on the flattened base the lirae curve forwards finally entering the umbilicus. Aperture subquadrangular, moderately oblique.

Dimensions.—

	Holotype F.46571	Paratype F.46572
Height	66 mm	76 mm
Width	67 mm	97 mm
Pleural angle	80°	95°
Width of aperture	29 mm	39 mm
Length of aperture	38 mm	47 mm

Remarks.—The holotype of this species is a beautifully preserved specimen with the exception of the aperture which is incomplete. It is smaller in size than the other ten specimens of a series considered to be conspecific with it. The material is from Harper's Hill in the Hunter River Valley.

This species is very similar in general appearance to *K. platyschismoides,* but differs from it in several important features. The shell is more conical in form, the shoulder at the upper suture is poorly developed and the whorl profile is steeply sloping and flattened. In *K. platyschismoides* the aperture is produced obliquely outwards whereas in *K. trochiforme* it is distinctly more vertical in position. In the latter species the columella lip is very thickened and appears to be reflected partly covering the umbilicus.

A specimen, from the Huon Road, Hobart, Tasmania, from an horizon thought to be the equivalent of the Berridale Limestone (Upper Marine Series), was figured by Johnston (1888: pl. xviii, figure 4), as *Platyschisma ocula* (Sowerby). This specimen is an example of the genus *Keeneia*, and it exhibits the characteristic features of *K. trochiforme*. The body whorl is steeply sloping, the shoulder is absent and the shell is more conical in appearance than in *K. platyschismoides* Etheridge. The specimen is the only one known from rocks other than the Allandale Formation, of the Hunter River Valley. A doubtful specimen is that figured, but not described, by Plews (1858: plate iv), as "*Platyschisma oculus*" from Harper's Hill. The illustration is very poor and one which would be impossible to identify specifically. Certain features indicate that possibly its place might be either with *K. platyschismoides* or *K. trochiforme*. The whereabouts of the specimen is unknown.

Localities and stratigraphical position.—Harper's Hill (type locality), Allandale, Duguid's Hill. Allandale Formation, Dalwood (Lower Marine) Group. Huon Road, near Hobart, Tasmania. Berridale Limestone (Upper Marine Series).

Keeneia ocula (Sowerby)

(Pl. 19, figures 1—7; pl. 20, figures 1—6).

Trochus oculus Sowerby, 1838: 15, pl. ii, figures 3—4.

Platyschisma oculus Morris, 1845: 286, pl. xviii, figure 1.

Euomphalus oculus de Koninck, 1877: 330, pl. xxiii, figures 18a—c.

Keeneia ocula Branson, 1948: 702.

Holotype (by monotypy): Specimen PG. 1061, figured by Sowerby 1838: pl. ii, figures 3—4. From "right bank of Hunter River"=Harper's Hill; Allandale Formation, Dalwood Group. Collection of the British Museum.

Description.—Medium sized, sub-globular; narrowly phaneromphalous gastropods of four to five whorls; penultimate and body whorls moderately inflated, remainder reduced and depressed; sutures shallow; whorl profile gently arched, steeply sloping from upper suture to subangulate to angulate periphery; lower half of body whorl flatly convex gaining in convexity towards the aperture; outer lip directed somewhat obliquely backward; a shallow sinus possibly developed at the periphery (not observed); junction of outer and inner lip angulate; columella lip fairly broad, flatly rounded, extending in a broad curve, backwardly directed, to the periphery and losing its thickness near that point; ornamentation numerous fine, transverse lirae, partly wavy, directed somewhat obliquely backward; crossing the periphery a further backward and then forward curve of the lirae forms a moderately shallow sinus, possibly indicative of the sinus of the outer lip; lirae on the base moderately straight; shell comparatively thick; aperture sub-oval.

Dimensions.—

	Holotype	Topotypes		
	PG.1061	F.27539	F.27535	F.46588
Height	44 mm	44 mm	36 mm	45 mm
Width	60 mm	59 mm	50 mm	62 mm
Pleural angle	100°	101°	98°	105°
Width of aperture		33 mm	27 mm	34 mm
Height of aperture		30 mm	23 mm	29 mm

Remarks.—Sowerby (1838: 15) named his specimen *Trochus oculus*, but gave no description His illustrations (pl. ii, figures 3—4) are to some extent idealised drawings of what is actually a rather poorly preserved specimen. Photographs of this specimen, the holotype PG.1061, were kindly forwarded to me by the British Museum and are reproduced. Photographs of the specimen described and figured by Morris (1845: 286) were also forwarded by the British Museum and there is no doubt it is conspecific with the holotype.

There is a considerable variation in the size of shells of *Keeneia ocula* (Sowerby) from the type locality. A large series of specimens from the Maitland Group of the Hunter Valley and particularly in the equivalent rocks, in part, of the South Coast, are smaller in size than typical examples of the species. Unfortunately the material is invariably poorly preserved, mainly in the form of steinkerns, and apertual characters are rarely present. However, it would appear that the species has an extensive vertical range in the Permian rocks of New South Wales, extending from the Lochinvar Formation of the Dalwood Group to the topmost beds of the Maitland Group and its equivalents.

The species was mentioned by M'Coy (1847 : 306) as common in the " aranaceous limestone " of Harper's Hill, with no other comments. De Koninck (1877 : 330; pl. xxiii, figure 18) described and figured the species as *Euomphalus oculus* (Sowerby), recording it from Harper's Hill and from a yellowish sandstone at Branxton. His material, subsequently destroyed in the Garden Palace fire at Sydney in 1882, was typical of the species. Johnston (1888 : pl. xvi, figure 3) figured what appears to be a steinkern from the Huon Road, near Hobart, Tasmania, and referred it to *Platyschisma oculus* (Sowerby). The specimen has not been examined and there is a possible doubt regarding its relationship with this species. It was mentioned earlier in this paper that the specimen figured by Johnston (1888 : pl. xvii, figure 4) as *Platyschisma oculus* (Sowerby), also from the Huon Road locality, appears to be conspecific with *Keeneia trochiformis* sp. nov. The specimens from Permian rocks in Queensland, described and figured by Etheridge (1892 : 286) as *Platyschisma oculus* (Sowerby) do not appear to be typical examples of the species. The shape of the body whorl and the aperture are very dissimilar.

Laseron (1910 : 220) recorded *Platyschisma oculus* (Sowerby) from several localities in the Lower Shoalhaven River area on the South Coast. The specimens were not figured and have subsequently been mislaid.

Etheridge (1902 : 198) considered that *Platyschisma oculus* (Sowerby) was generically distinct from his genus *Keeneia*. In shells of that genus there is developed on the periphery of the body whorl a distinct flattened band or pseudo-selenizone, defined by the striae which at this point sweep deeply concave backwards. In *P. oculus* there is only a slight inflection, or curving backwards of the striae on passing over the obtuse periphery of the body whorl. Apart from the great difference in size there is a distinct general resemblance between the two species and I agree with Branson and Brookes Knight (1948 : 702) that they are congeneric. This resemblance is particularly noticeable in the specimens figured on pl. xiv, figure 1 and pl. xix, figure 4.

I cannot agree, however, with the above authors in their suggestion that *Keeneia platyschismoides* and *Keeneia ocula* are conspecific. The flattened peripheral band of the former, together with the acutely inflected striae and sharply angulate periphery, are markedly different from the more rounded periphery of *K. ocula* and only slightly and broadly backwardly inflected striae of that species as they cross the periphery. Furthermore, apart from the great difference in size, the whorl faces of *Keeneia platyschismoides* are steeply sloping and flattened in contrast with the more moderately and evenly inflated whorls of *K. ocula*. Both species are distinct forms and are readily recognised.

Morris (1845 : 286) when he described *Platyschisma rotundatum*, remarked that it could possibly be a variety of *P. oculus* (Sowerby). Etheridge (1919 : 188) rightly considered them to be distinct species.

Localities and stratigraphical positions.—Lochinvar; Lochinvar Formation. Harper's Hill, Allandale; Allandale Formation, Dalwood (Lower Marine) Group. Branxton; Branxton Sub-group; Maitland (Upper Marine) Group. Wyro, near Ulladulla, Ulladulla; Shoalhaven (Upper Marine) Group. Wollongong, Gerringong; Gerringong (Upper Marine) Volcanics. Bundanoon; (Upper Marine). Rylstone; Capertee (Upper Marine) Group.

Genus **Planikeeneia** nov.

Type Species : *Planikeeneia minor* sp. nov., Harper's Hill. Allandale Formation, Dalwood (Lower Marine) Group.

Description.—Moderately medium sized to large, low-spired gastropods of four to five whorls with low convexity; a narrow sinus in the outer lip; a pseudo-selenizone occasionally; whorl profile gently arched between sutures; angulate to sub-angular on periphery of body whorl; base flatly convex; sutures moderately deep. Ornamentation numerous to crowded fine, sharp, transverse lirae, deflected backwards on the periphery of the body whorl.

Remarks.—This genus is introduced for the following species which are depressed, low-spired gastropods, with whorls of low convexity : *Planikeeneia minor* sp. nov., *Planikeeneia occasa* sp. nov. *Platyschisma depressum* Dana and *Planikeeneia insculpta* sp. nov.

These species with the exception of *P. occasa* sp. nov., are associated in the Allandale Formation of the Dalwood (Lower Marine) Group at Harper's Hill. *Planikeeneia occasa* is found in the Branxton (Upper Marine) Sub-group and also occurs in its equivalent beds in the South Coast.

It is considered that the above species are precluded fron the genus *Platyschisma* M'Coy 1844, by the development of the distinctly angulate periphery of the whorls and the depressed spire. It was suggested by Etheridge (1902 : 199) that *Platyschisma depressum* Dana should be referred to his genus *Keeneia*. The shells of that genus are very dissimilar to those of *Platyschisma depressum* Dana, and the species is referred to the new genus *Planikeeneia*.

Planikeeneia minor sp. nov.

(Pl. 14, figures 3—6.)

Platyschisma oculus Etheridge (non Sowerby), 1898 : 176, pl. xix, figures 14—17.

Keeneia depressum Etheridge (non Dana) 1919 : 188—189. Specimen from Lochinvar.

Holotype : Specimen F.46578, figured by Etheridge 1898 : pl. xix, figures 14—17. From Harper's Hill. Dalwood (Lower Marine) Group.

Paratype : Specimen F.6640, mentioned by Etheridge 1919 : 188—189, from same locality and horizon as the holotype.

Description.—Moderately small, low-spired and depressed gastropods, five to six whorls of low convexity, narrowly phaneromphalous; sutures distinct, shallow; whorl profile sub-angulate, sharply angulate in steinkerns, upper surface broadly convex, slightly shouldered below the upper suture; a pseudo-selenizone developed on the periphery; lower surface of whorl flatly convex; columella lip thickened, reflexed, increasing in strength towards its junction with the slightly curved lower lip; character of outer lip not observed; aperture oval, obliquely transverse; ornamentation numerous fine, transverse lirae, 18—30 in 5 mm, directed obliquely backward to the periphery where they bend sharply back and forward again to form a narrow apparent band or pseudo-selenizone; below the periphery the lirae extend to the umbilicus in a somewhat sigmoidal manner.

Dimensions.—

	Holotype F.46578	Paratype F.6640
Height	22 mm	32 mm
Width	37 mm	57 mm
Pleural angle	130°	132°
Height of aperture	16 mm	...
Width of aperture	22 mm	...

Remarks : The holotype of this species was originally described and figured by Etheridge (1898 : 176) as a very depressed form of *Platyschisma oculus* (Sowerby), at the same time stating, however, that it could with justification be regarded as a new species.

Etheridge (1919 : 188—9) recorded, but did not figure, a specimen from Lochinvar as *Keeneia depressum* (Dana). He remarked on the " peripheral band " truncating the entire edge or keel, which in his opinion corresponded to the " back sub-truncate" of Dana's species. The specimen is quite unlike *P. depressum* Dana, but agrees very well with a series of about twenty specimens of this species from Harper's Hill. It bears a superficial resemblance to the smaller shells of *Walnichollsia pygmaea* sp. nov., from the South Coast, differing, however, in having a distinct angulate whorl periphery and an entirely different type of ornamentation.

Localities and stratigraphical positions.—Lochinvar, Lochinvar Formation; Harper's Hill Allandale Formation; Ravensfield, Farley Formation; Dalwood (Lower Marine) Group.

Planikeeneia depressum (Dana)

(Pl. 17, figures. 1—2; Pl. 18, figures 1—2.)

Platyschisma ? depressum Dana, 1847 : 151.

Platyschisma depressum Dana, 1849 : 707, pl. x, figures. 2a, b.

Platyschisma allandalensis Mitchell, 1923 : 278, pl. xxxv, figures 1—2.

Holotype (by monotypy) : Specimen figured by Dana 1849 : pl. x, figures 2a, b. From Harper's Hill, Allandale Formation, Dalwood Group. Collection of the United States National Museum, Washington.

Description.—Large to medium sized, somewhat explanate, phaneromphalous gastropods of four to five whorls; much wider than high; whorls of the spire much reduced, depressed; sutures narrow, not deep; whorl profile flattened for most of the distance from the suture to the periphery which is narrow, sub-truncate to rounded; base flatly convex; aperture elongate-oval, almost horizontal in position; outer lip moderately oblique backwards from the upper suture, a narrow insinuation on the periphery, not a notch or slit, continuing with the same obliquity on the base; apertural characters not preserved; ornamentation fairly coarse transverse lirae; transverse grooves following the direction of growth, well developed on the whorls; shell thick, particularly at junction of whorls.

Dimensions.—

	Plastotype	Mitchell's Specimen	Topotype
	L.694	F.27084	F.27085
Height	47 mm	68 mm.	51 mm
Width	109 mm	118 mm	105 mm
Pleural angle	140°	140°	147°
Height of aperture	...	47 mm	30 mm
Width of aperture	...	70 mm	75 mm

Remarks.—Dana (1847 : 151) and later in 1849, (p. 707) stated that this species " differs widely from the *oculus* in its very depressed form, and flattened whorls, the outer of which has the back sub-truncate ". His specimen has a width of 4½ in and the surface is unevenly and coarsely marked with striae of growth. A plastotype (L. 694) of Dana's holotype, proves very conclusively that it is a distinct species and because of the very depressed nature of the shell is considered as referable to the genus *Planikeeneia*.

Etheridge (1919 : 188) was of the opinion that Dana's specimen was crushed from above, but after an examination of a plaster replica of the holotype he agreed that Dana's description was strictly accurate. Etheridge also recorded, but did not figure, a much smaller specimen, F.6640, from Lochinvar in the Hunter River Valley, which he thought agreed with Dana's description of *P. depressum* in that a peripheral band is developed truncating the entire edge or keel. This specimen is an adult shell of *Planikeeneia minor* sp. nov.

Mitchell (1922 : 278) described and figured a single large shell from Allandale, near Harper's Hill, as *Platyschisma allandalensis*. The specimen is a steinkern with practically none of the original shell material preserved. The periphery is to some extent more rounded than Dana's specimen, but there is no doubt that the two are conspecific. Mitchell records " a notch or gape " in the outer lip of his specimen, similar to what is found in the present-day genus *Ianthina* and the species *Platyschisma oculus* (Sowerby). This character is not a well marked feature and if present is in the form of a very shallow insinuation and certainly not a distinct notch.

The shell in this species is thick and in decorticated specimens a considerable space is left around the upper suture of the body whorl where the shell attained a maximum thickness.

Localities and stratigraphical position.—Harper's Hill, Allandale; Allandale Formation, Dalwoo (Lower Marine) Group.

Planikeeneia occasa sp. nov.

(Pl. 18, figures 3—6.)

? *Platyschisma rotundatum* var. *farleyensis* Etheridge, 1919 : 189, pl. xxviii, figure 9.

Holotype : Specimen No. F.28295, from Branxton, Hunter River Valley, Elderslie Formation, Branxton (Upper Marine) Sub-group.

Paratype : F.29869, same locality and horizon.

Description.—Moderately small, low-spired, sub-discoidal, narrowly phaneromphalous gastropods of four whorls; a wide shallow sinus in the outer lip; body whorl produced transversley, somewhat explanate; whorl profile gently arched between sutures, a flattened area below the upper sutures; periphery of body whorl sub-angulate; base flatly convex; sutures shallow, whorls overlapping preceding ones to a marked extent; columellar lip rounded, thickened above, tapering and broadly curved with a slight obliquity backwards to the sinus; outer lip thin directed moderately obliquely backward produced considerably in front of the inner and lower lip; aperture oval, obliquely transverse. Ornamentation numerous fine lirae with distinct occasional growth ridges; a slight inflection or curving backwards of the lirae as they cross the periphery.

Dimensions.—

	Holotype F.28295	Paratype F.29869
Height	30 mm	31 mm
Width	47 mm	46 mm
Pleural angle	122°	130°

Remarks.—This species is represented by a series of 11 well preserved specimens from Branxton, Greta and Richmond Vale in the Hunter River Valley. A single steinkern in the series agrees very well with a suite of steinkerns from Farley, described by Etheridge (1919 : 189) as *Platyschisma rotundatum* var. *farleyensis*. He recorded the internal casts as of less than the normal dimensions of *P. rotundatum* Morris and stated that " the sulci resulting from the protrusion of the inner shelly ribs, described by Morris, are always in evidence ". This is apparently not the case entirely as many of his specimens show no trace of sulci. Steinkerns invariably show more rounded whorls than specimens still retaining the original shell. There is such a strong similarity between the two forms that they are tentatively considered to be conspecific.

The internal casts described by Etheridge are from the Farley Formation, Dalwood (Lower Marine) Group, while complete specimens of *P. occasa* are from the Elderslie Formation of the Branxton (Upper Marine) Sub-group. The two formations are separated by the Greta Coal Measures with a thickness of 200 ft.

It is also possible that this species is represented at Gerringong in rocks of the Westley Park Tuff (Gerringong Volcanics). The material, however, is poorly preserved and a definite identification is impossible.

This species is somewhat similar in appearance to *Platyschisma branxtonensis* sp. nov. with which it is associated in the same horizon. It differs in being a more explanate type of shell, in the presence of a sub-angulate periphery and different ornamentation.

Localities and stratigraphical positions.—Farley; Farley Formation, Dalwood Group. Branxton, Greta, Richmond Vale; Elderslie Formation, Branxton Sub-group. ? Gerringong; Westley Park Tuff, Gerringong Volcanics.

Planikeeneia insculpta sp. nov.

(Pl. 17, figures 3—5.)

Holotype : Specimen No. F.29904, from Allandale; Allandale Formation, Dalwood Group.

Description.—Moderately large, sub-discoidal narrowly phaneromphalous gastropods of five whorls with a possible narrow sinus in the outer lip (not observed); body whorl produced somewhat transversely with a sub-angulate periphery; whorl profile rounded from the upper suture to the periphery, with a narrow depressed, flattened area below the upper suture; periphery sub-angulate, base flatly convex; sutures shallow; aperture sub-quadrangular, lower lip straight; columellar lip thickened, flattened and reflexed, increasing in width towards its junction with the lower lip. Ornamentation crowded sharp, fine striae, curved obliquely backwards to the periphery, where as they cross, a moderately deep sinus is developed to form a pseudo-selenizone; striae straight on the base; an indistinct series of spiral striae can be traced in the form of faint ridges between the transverse striae.

Dimensions.—

	Holotype
Height	40 mm
Width	64 mm
Pleural angle	140°

Remarks.—This species is represented by a single beautifully preserved specimen from Allandale. It is an outstanding depressed form with a distinct band or pseudo-selenizone on the periphery of the body whorl, and characteristic ornamentation. It has a superficial resemblance to *P. occasa* sp. nov., from higher in the Permian sequence, but is readily distinguished by its more inflated body whorl and entirely different shape of the aperture and columellar lip.

Dun (1913 : 8) described and figured a small low-spired gastropod from the Tasmanite Spore beds of the Mersey River, Tasmania, as *Keeneia twelvetreesi*. It has points of resemblance to *Planikeeneia insculpta* sp. nov. particularly in the strong inflection of the growth lines forming a slightly raised band on the periphery of the body whorl. The holotype of *K. twelvetreesi* Dun has been mislaid and until it can be found and examined a relationship between the two species is only suggested.

Locality and stratigraphical position.—Allandale; Allandale Formation, Dalwood Group.

Genus **Mourlonia** ? Koninck 1883

Mourlonia ? *waterhousei* Etheridge

Mourlonia ? *Waterhousei* Etheridge, 1898 : 17, pl. i, figures 7—8.

Remarks.—This is a most outstanding species of the Permian gastropod fauna of New South Wales. Etheridge's description is : " Shell depressed turreted, deeply umbilicate; whorls four (as far as preserved); upper whorls nearly straight-walled, flat and tabulate above, sharply keeled at the peripheries; body whorl generally rounded above and below, bearing three spiral keels, one peripheral in position, a second supra-peripheral, and a third similar, but rather more widely separated from the second than the first and second are from one another; surface, except the space between the first and second keels, which is concave and plain, traversed by spiral raised lines, with traces of indistinct obtuse, or flattened varices, especially on the body whorl ".

The mouth and apex are not preserved on the material described by Etheridge. He considered that the only other Australian Permian species it resembled is *Walnichollsia subcancellata* (Morris), differing from it, however, in many essential features. Unfortunately the specimens described by Etheridge have been mislaid in the collection of the Mining and Geological Museum, Sydney, and I know of no other specimens. It is apparently a most distinctive species and cannot be compared with any known gastropod from the Permian of Australia.

Locality and stratigraphical position.—A quarter of a mile north-west of the Water-works, West Maitland, Hunter River Valley; Muree Formation of the Branxton Sub-group or the Mulbring Sub-group, Maitland (Upper Marine) Group.

Genus **Pleurocinctosa** nov.

(*Pleura*, side; *Cinctosa*, girded)

Type Species : *Pleurotomaria trifilata* Dana, 1847 : 150.

Description.—Small moderately high-spired, minutely phaneromphalous or anomphalous gastropods, mainly of four to six whorls; a narrow sinus in the outer lip culminating in a narrow, deep selenizone bordered on either side by an acute carina, the lower forming the periphery; whorl profile gently arched above and below the selenizone; base roundly subconical; whorls overlapping on previous whorls close to selenizone; columella lip flattened, somewhat arcuate, considerably thickened and reflexed; aperture oval; ornamentation oblique transverse lirae.

Remarks : Species of this genus have been referred in the past to *Pleurotomaria*, *Ptychomphalina* and *Murchisonia*. It is now recognised that the name *Pleurotomaria* is not valid for Palaeozoic forms and the new genus *Pleurocinctosa* has been introduced for the three species from New South Wales, *P. trifilata* (Dana), *P. allandalensis* sp. nov. and *P. elegans* sp. nov. It differs from the genus *Ptychomphalina* Fischer 1885 (genotype *Helix* ? *striatus* Sowerby 1817) in its more erect spire, an acute pleural angle and the gradual and even increase in the size of the whorls, which do not overlap to the selenizone.

The genus *Murchisonia* Archiac and Verneuil 1841 (genotype *Muricites turbinatus* Schlotheim 1820), from the middle Devonian rocks of Germany, is represented by high-spired shells with the whorl profile concave above and below the selenizone, a feature absent in the Australian shells. The genus *Pleurocinctosa* resembles somewhat superficially the shells of *Goniostropha* Oehlert 1888, which are however high-spired and the selenizone separates the whorl faces into equal upper and lower surfaces.

There is a close relationship between shells of *Pleurocinctosa* and those of the genus *Peruvispira* Chronic 1949, (genotype *P. delicata*), from the lower Permian of Peru. An important difference is the strongly developed columella lip of *Pleurocinctosa* and other apertural features.

It is considered that *Pleurocinctosa trifilata* (Dana), a small somewhat conical species from the Maitland (Upper Marine) Group and its equivalents, and *P. allandalensis* sp. nov., from the Dalwood (Lower Marine) Group, are both essentially bicarinate groups. A third carina is occasionally represented by a spiral ridge bordering an ill-defined sulcus below the selenizone. A third species, *P. elegans* sp. nov., is comparatively rare and has been recorded only from the Belford Formation of the Maitland Group in the Hunter River Valley. It is a definite tricarinate form and is quite distinct from *P. trifilata* (Dana) and *P. allandalensis* sp. nov.

Pleurocinctosa trifilata (Dana)

(Pl. 11, figures 3—6)

Pleurotomaria (nearly related to *P. conica* Phillips) Morris, 1845 : 288.

Pleurotomaria trifilata Dana, 1847.

Pleurotomaria morrisiana M'Coy, 1847 : 306, pl. xvii, figure 5.

Pleurotomaria morrisiana Dana, 1849 : 706, pl. ix, figures 15, 15a, (non figure 16).

Pleurotomaria morrisiana Koninck, 1877 : 321, pl. xxiii, figure 12.

Lectotype (here chosen) : Specimen figured by Dana 1849 : 706, pl. ix, figures 15, 15a, from Black Head, near Gerringong. Westley Park Tuff, Shoalhaven (Upper Marine) Group. Collection of the United States National Museum, Washington.

Description.—Somewhat conical, moderately high-spired, minutely phaneromphalous or anomphalous gastropods of four whorls, occasionally five; a narrow sinus in the outer lip culminating in a deep, narrow selenizone lying between two acute carinae, the lower forming the periphery of the whorl; whorl profile gently arched and steeply sloping above the selenizone, convex below; base rounded, sub-conical; aperture circular, parietal inductura thin; columella lip thickened, arcuate, considerably reflexed and sutures moderately deep; ornamentation very fine crowded lirae, obliquely directed backward from the upper suture to the selenizone, straight with slight forward curvature on base.

Dimensions.—

	F.21396
Height	11 mm
Width	7·5 mm
Pleural angle	50°

Remarks.—Dana (1847 : 150) described this species as occurring at Harper's Hill, Dalwood (Lower Marine) Group, and also from Illawarra, Gerringong (Upper Marine) Volcanics. His material must have included specimens of two species. The description of his species is almost certainly that of a shell from Illawarra and is as follows : " Shell rather short turreted, whorls four, separated by a distinct suture, back tricarinate, the middle carina largest, subacute, aperture orbicular ". The dimensions of the shells he referred to as " large specimens " are " eight lines long, and five broad at base ". These are the elongate shells found in abundance at Harper's Hill and consist of at least six or more whorls. They are distinct from the smaller conical shells from the Illawarra district.

Morris (1845 : 288) was actually the first author to record the presence of this species at Illawarra. In discussing the affinities of his *Pleurotomaria subcancellata*, he mentioned a well-defined impression of another species with a bicarinated mesial band, and numerous small, oblique, rather acute striae on each volution. Morris considered it to be a " species of *Pleurotomaria*, nearly related to *P. conica* Phillips, as it is small, elongated and acutely conical ".

M'Coy (1847 : 306) described and figured the small conical form from Black Head, near Gerringong, as *Pleurotomaria morrisiana*. His figure (1847 : pl. xvii, figure 5) is a typical example although the whorl faces are incorrectly illustrated as being concave. Dana (1849 : 706) redescribed the small conical form, but again records the dimensions of the larger shells from Harper's Hill. He also states that " the specimens from Harper's Hill are mostly larger than those from Illawarra ..... ". Dana accepted the fact that his shells were conspecific with those described by Morris and incorrectly adopted M'Coy's specific name *morrisiana* in preference to his earlier *trifilata*. He considered " the honour is well due to Mr. Morris ..... ". Such a change of name is against the accepted Rules of Nomenclature and Dana's original specific name *trifilata* must stand with M'Coy's specific name *morrisiana* as a synonym. The specimen figured by Dana (1849 : pl. ix figure 15a) shows three carinae encircling the whorls and is from Illawarra.

Koninck (1877 : 327) described but did not figure the more elongate and larger form as *Murchisonia trifilata* Dana. He placed as synonyms, *Pleurotomaria trifilata* Dana 1847, and *P. morrisiana* Dana 1849, exclusa figure 15, (non M'Coy). Koninck's specimens which came from Harper's Hill are described as elongated conical shells composed of seven or eight whorls with a triple keel. The dimensions are length " about 20 mm and a diameter of from 9 to 10 mm ". Its pleural angle is about 51°.

Koninck referred this form to the genus *Murchisonia* because of its greater relative length, and this fact, together with the smallness of the spiral angle and the presence of a triple keel, made him conclude it was distinct from *P. morrisiana* M'Coy, which has a double keel. This conclusion is correct, but it is considered that Dana's descriptions of *P. trifilata*, both in 1847 and 1849, refer to the small conical shell with four to five whorls, and his name must be used for them. The specimen figured by Dana (1849 : pl. ix, figure 15, and enlarged figure 15a) is from Illawarra. The specimen figured by him on Plate ix, Figure 16, is from Harper's Hill. The elongate form with six to seven whorls from Harper's Hill is described later in this paper as *Pleurocinctosa allandalensis* sp. nov.

Koninck (1877 : 321) redescribed and figured *Pleurotomaria morrisiana* M'Coy, from Minnamurra, near Gerringong. It is the small conical form with four to five whorls, a double keel, and a pleural angle of 60°. It is the form recognised in this paper as *P. trifilata* (Dana).

It would appear from a close study of more than four hundred specimens of *P. trifilata* and *P. allandalensis* that the former is restricted mainly to rocks of the Gerringong (Upper Marine) Volcanics of the South Coast in which it is abundant. The latter species is restricted to the Dalwood (Lower Marine) Group of the Hunter Valley where it is abundant in the Lochinvar and Allandale Formations. It is also widely distributed in rocks of equivalent age in New South Wales.

It has been noticed that both bicarinate and tricarinate shells of *P. trifilata* (Dana), occasionally occur together in the same matrix and are obviously the same species. The narrow, deep selenizone lies above the periphery of the whorls and is bordered by an acute upper carina and a slightly stronger lower carina forming the periphery of the whorl. Immediately below the periphery is an ill-defined encircling narrow sulcus which is hardly discernible in well preserved specimens. Its lower margin is bordered by a faint ridge and in weathered specimens the ridge becomes more distinct and forms a third carina. It is suggested that this may be the explanation of the tricarinate nature of certain shells of *P. trifilata* and *P. allandalensis*, but not *P. elegans* in which a definite tricarination is developed.

Koninck (1877 : 329) described and figured a small elongate conical form of shell from Minnamurra, near Gerringong, as *Murchisonia verneuiliana* Koninck. It has a small narrow selenizone, limited by two slightly grooved carinae, placed almost centrally on the whorls. Its length is about 10 mm, diameter 7 mm, and the pleural angle is 41°. No further specimens of this species have come to my notice. It could possibly be a fourth species of *Pleurocinctosa*.

Localities and stratigraphical positions.—Gerringong; Black Head, near Gerringong; Minnamurra, near Gerringong; Crooked River, near Gerringong. Westley Park Tuff, Gerringong (Upper Marine) Volcanics. Rylstone. Base of Capertee (Upper Marine) Group. Muree. Branxton Sub-group, Maitland (Upper Marine) Group.

Pleurocinctosa allandalensis sp. nov.

(Pl. 11, figures 7—9; Pl. 12, figures 2—3)

Pleurotomaria morrisiana Dana, 1849 : 706, pl. ix, figure 16 (non figure 15, 15a).

Murchisonia trifilata, Koninck, 1877 : 327.

Holotype : Specimen figured by Dana, 1849, pl. ix, figure 16. Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group. Collection of the United States National Museum, Washington.

Description.—Small moderately high-spired gastropods of six to eight whorls; minutely phaneromphalous or anomphalous; outer lip with a possible narrow sinus culminating in a short slit that gives rise to a peripheral selenizone (actual sinus and slit not clearly observed); selenizone moderately deep, concave, lying between two acute carinae, the lower and stronger projecting slightly beyond the upper and forming the periphery of the whorl; whorl profile gently arched from the upper suture to the selenizone; below the selenizone a narrow groove is developed bordered by a spiral ridge, varying in strength and occasionally appearing as a third carina; base rounded; sutures fine somewhat linear; aperture circular, parietal lip thin with a thin inductura; columella lip swollen, flatly rounded, slightly reflected; ornamentation numerous fine, sharp and even transverse lirae, with a gentle forward, curve, but obliquely directed backward to the selenizone; lunulae fine, vertical; lirae forwardly curving to the umbilicus below; shell thin.

Dimensions.—

	F.27545	F.27545
Height	16 mm	16 mm
Width	9 mm	10 mm
Pleural angle	32°	40°

Remarks.—The status of this species with the preceding *Pleurocinctosa trifilata* (Dana) has already been discussed. As pointed out Dana (1847 : 150) obviously had two distinct forms in the material used for his description of *Pleurotomaria trifilata*, a small conical shell of four whorls from Illawarra, and a larger elongate form with six to eight whorls from Harper's Hill.

Dana's description is almost certainly based on the conical form from Illawarra and furthermore, later in 1849 (pl. ix, figures 15, 15a) he figured a specimen and an enlarged whorl of the same form. Unfortunately he also figured on plate ix, figure 16, a specimen of the second species from Harper's Hill. The measurements of the species are apparently based on a specimen from the same locality and now recognised as *P. allandalensis*.

Dana (1849 : 706) recognised that his species was conspecific with the species described by M'Coy as *Pleurotomaria morrisiana*, but incorrectly adopted this specific name in preference to his own of earlier date. Dana's name *P. trifilata* must stand for the small conical shells from the South Coast and M'Coy's species, *P. morrisiana*, becomes a synonym of it. This leaves the elongated shells of six to eight whorls from Harper's Hill without a name and the species *Pleurocinctosa allandalensis* sp. nov. has been introduced for them.

The species was described in detail by Koninck (1877 : 327) when he named elongate shells from Harper's Hill as *Murchisonia trifilata* (Dana). He stated that a block of greenish, calcareous sandstone was full of specimens of this species. He pointed out that Dana confused his species with *Pleurotomaria morrisiana* M'Coy. Koninck apparently agreed that Dana's specimen figured on Plate ix, Figures 15 and 15a, even though tricarinate, are conspecific with *P. morrisiana* M'Coy, as in his synonomy of *Murchisonia trifilata* he included only Dana's specimen figured on Plate ix, Figure 16. These assumptions are correct except that in my opinion Koninck was in error in retaining Dana's name *Pleurotomaria trifilata* for the shells from Harper's Hill. The enlarged whorl of the specimen illustrated by Dana (1849 : pl. ix, figure 15a) according to its profile is definitely a specimen from Illawarra and is conspecific with *P. morrisiana* M'Coy. The tricarinate character of these shells was discussed earlier in this paper.

The species, *Pleurocinctosa allandalensis* sp. nov., first appears in the Lochinvar Formation at Lochinvar, where in shales about 1,280 ft. from the base of the Dalwood Group it is not uncommon. The shells are mainly steinkerns. It is fairly widely distributed in rocks of the Dalwood Group of the Hunter River Valley and its equivalents in New South Wales. There is some variation in size and also in ornamentation. Shells from the Macleay Group in the Manning-Macleay Province possess slightly heavier lirae than found on typical examples from the type locality at Harper's Hill.

Localities and stratigraphical positions.—Lochinvar; Lochinvar Formation. Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group. Yessabah; Tait's Creek Formation. Kimbriki; Warbro Formation, Macleay Group.

Pleurocinctosa elegans sp. nov.

(Pl. 12, figure 1)

Holotype : Specimen No. F.46587, from Richmond Vale, Hunter River Valley. Elderslie Formation, Branxton Sub-group, Maitland (Upper Marine) Group.

Description.—Small, moderately high-spired, minutely phaneromphalous or anomphalous gastropods of five or six distinct, sub-angulated whorls; sinus or slit not observed; moderately deep, narrow selenizone between two well marked and acute carinae; the lower carina projecting beyond the other and forming the periphery of the whorl; a third carina bordering a definite spiral groove immediately underlying the periphery; whorl profile sub-angular at the periphery, straight, steeply sloping above, gently arched below; base broadly arched; sutures fine; junction of whorls with preceding ones moderately recessed well below selenizone; aperture oval; peristome not observed; ornamentation consists of numerous, closely crowded, fine lirae.

Dimensions.—

Height	6 mm
Width	4 mm
Pleural angle	30°

Remarks.—This species is represented in the collection by a number of shells embedded in a small piece of fine sandstone from Richmond Vale in the Hunter River Valley and is apparently abundant at that locality. It is not possible with the available material to determine the characters of the inner or outer lips and the sinus and slit are unknown.

The species is readily recognised from other species of the genus by its very small size, well differentiated whorls and slender spire. The whorls are tricarinate although occasionally the third carina below the periphery is absent.

Locality and stratigraphical position.—Richmond Vale; Elderslie Formation, Branxton Sub-group, Maitland (Upper Marine) Group.

? **Pleurocinctosa nuda** (Dana)

Pleurotomaria nuda Dana, 1847 : 151.

Pleurotomaria nuda Dana, 1849 : 706, pl. ix, figure 17.

Remarks.—From the description of this species by Dana (1847 : 151 and 1849 : 706), it could well belong to the above genus. The shells are " short, conical, angle of spire about 115°; whorls four or five rounded, separated by a suture, smooth, slightly carinated, with another obsolete carina either side ". The dimensions are length half-an-inch; breadth about three-quarters of an inch. The specimens figured by Dana (1849 : pl. ix, figures 17a, b, c,), show few distinct characters with the exception that the aperture is apparently very obliquely and transversely produced. This feature is not revealed markedly in a plastotype I have examined of possibly the specimen represented by his

Figure 17c, a basal view. To my knowledge no additional specimens of this species have been collected from the type locality at Harper's Hill or elsewhere. The species is characterised by shells with a large body whorl, seemingly tricarinate, and a low short spire of three to four whorls. It has been placed tentatively in the genus *Pleurocinctosa*.

Waagen (1891 : 120) recorded a single shell as this species from the upper limit of the boulder beds at Dillur in the Salt Range of India. It has a certain resemblance to the Australian shells, but certain differences in the description and figures indicate they are not conspecific. The body whorl in Dana's specimens is much larger in proportion to the spire than shown in Waagen's figures (1891 : pl. iv, figures 4a, b, c,) and the shape of the aperture is very dissimilar.

Locality and stratigraphical position.—Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group.

Genus **Walnichollsia** nov.

(A proper name)

Type Species : *Pleurotomaria subcancellata* Morris 1845.

Description.—Large sub-turbinate, thin-shelled, widely phaneromphalous gastropods of five whorls; body whorl extended somewhat transversely; whorl profile rounded at the periphery, gently arched above and below; no apparent sinus on the outer lip (not actually observed); an ill-defined, shallow selenizone is developed lying between two faint carinae barely distinguishable from the spiral costae, and developed on the periphery; aperture elongate-oval, obliquely transverse; ornamentation strong spiral costae crossed by finer transverse lirae, forming a definite lattice structure.

Remarks.—As already mentioned in this paper the genus *Pleurotomaria* Sowerby 1816 cannot be used for Palaeozoic species. It is a Jurassic genus and quite unlike any Palaeozoic gastropods, a fact made clear by Knight (1941 : 21).

Morris (1845 : 288) noted a close resemblance of his species to *Pleurotomaria delphinuloides* Goldfuss.=*Helicites delphinuloides* Schlotheim 1820, from the middle Devonian of Germany. This species is the genotype of *Euryzone* Koken 1896, a genus to which *Walnichollsia* gen. nov. bears a strong resemblance. It differs, however, in the more erect nature of the shell, more inflated whorls, a wider umbilicus and strong characteristic spiral costae.

The genus *Walnichollsia* is represented by two species, *N. subcancellata* (Morris) and *N. pygmaea* sp. nov., both occurring in rocks of the Maitland (Upper Marine) Group and its equivalents.

The genus was named after Mr. W. Nicholls of Rylstone, who devoted many years to the collecting of fossil material in that district.

Walnichollsia subcancellata (Morris)

(Pl. 13, figures 1—6)

Pleurotomaria cancellata Strzelecki, 1845 : 91. (nom. nud.).

Pleurotomaria subcancellata Morris, 1845 : 288, pl. xviii, figure 6.

Pleurotomaria subcancellata M'Coy, 1847 : 305.

Pleurotomaria cancellata Grange, 1854 : 89.

Pleurotomaria subcancellata Koninck, 1877 : 322.

Holotype (by monotypy) : Specimen figured by Morris 1845 : pl. xviii, figure 6, from Illawarra; Gerringong (Upper Marine) Volcanics, in the collection of the British Museum.

Description.—Large sub-turbinate, thin-shelled, widely phaneromphalous gastropods of five whorls, moderately high-spired; a possible sinus (not observed) in the outer lip culminating in an indistinct selenizone forming the periphery of the whorl; selenizone shallow, narrow, bordered by two faint carinae or more strongly developed costae; whorls inflated, the body whorl produced somewhat transversely; whorl profile narrowly rounded at the periphery, gently arched above and below; sutures moderately wide and deep; aperture elongate-oval, transversely oblique; ornamentation coarse spiral costae, lightly crossed by fine transverse lirae, slightly nodular at intersections, but more in the form of fine vertical ridges in the comparatively wide inter-costal spaces.

Dimensions.—

	F.45348	F.43066
Height	45 mm	52 mm
Width	63 mm	72 mm
Pleural angle	98°	110°

Remarks.—This species is a very thin-shelled form and to some extent shells have been considerably flattened by pressure. The ornamentation on many specimens is not well preserved because of weathering, but the strong spiral costae are usually present. The selenizone is not a well marked character.

The species is represented by a large series of specimens agreeing perfectly with the holotype figured by Morris (1845 : pl. xviii, figure 6) which has a diameter across the base of 2½ inches. His specimen is incomplete, the upper whorls of the spire being missing, but the essential characters of the genus and species are well shown. The same specimen was re-figured later by Koninck (1877 : 322, pl. xxiii, figure 15) who recorded the species from Muree in the Hunter Valley. M'Coy (1847 : 305) listed the species as occurring at Loder's Creek, Hunter River Valley. Waagen (1932 : 65) thought that perhaps this species was allied to *Pleurotomaria brenensis* Waagen, from the Agglomeratic Slate of Kashmir, but finally concluded they were dissimilar.

Localities and stratigraphical position.—Loder's Creek, Branxton, Muree, (Hunter River Valley); Branxton Sub-group, Maitland (Upper Marine) Group. Wollongong, Jamberoo, Broughton, near Berry, (Illawarra District); Gerringong (Upper Marine) Volcanics. Ulladulla; Shoalhaven Group, Rylstone (Western Coalfield); Capertee (Upper Marine) Group. Bundanoon, (Southern highlands); " Upper Marine Series ".

Walnichollsia pygmaea sp. nov.

(Pl. 12, figures 4—8)

Holotype : Specimen No. F.46585, Black Head, near Gerringong, New South Wales; Westley Park Tuff Formation, Gerringong Volcanics (Upper Marine).

Paratypes : Specimen F.21594, from the same locality and horizon. Specimens F.21576, F.21634 Wyro, near Ulladulla; Ulladulla Mudstone, Shoalhaven (Upper Marine) Group.

Description.—Moderately small gastropods, much wider than high with five whorls; a low spire only slightly elevated above the body whorl; widely phaneromphalous; outer lip without a distinct sinus; an indistinct selenizone developed on the whorl periphery; whorl profile transversely oval, gently convex upper and lower surfaces, narrowly rounded on outer-face; peristome moderately thickened; outer lip gently arched from the suture to periphery, straight and directed obliquely backward below; aperture transversely elongate-oval. Ornamentation fairly numerous close-set spiral costae with numerous fine transverse lirae developed more as ridges in the inter-costal spaces and forming a minute lattice structure. Shell thin.

Dimensions.—

	Holotype F.46585	Paratype F.21634
Height	16 mm	19 mm
Width	36·5 mm	36 mm
Pleural angle	150°	152°

Remarks.—This species is represented by a series of fourteen specimens including several well preserved examples. It is a thin-shelled form and the body whorl in some cases has been flattened by pressure forming an apparent carinate periphery. A paratype (F.21594) is one of the few Permian gastropods from New South Wales in which an almost complete peristome is preserved. In steinkerns it is bordered by a distinct shallow groove. The presence of a selenizone although indicated on several specimens is a doubtful character and if present is very faint. There is seemingly no trace of a sinus on the outer lip.

This species together with *Walnichollsia subcancellata* (Morris), is easily recognised by the very characteristic ornamentation, the wide rather flattened whorls and transversely produced aperture. It differs from *W. subcancellata* in its much smaller size and low, almost flattened spire. It was considered that the specimens of this species may be immature shells of *W. subcancellata*, but it is most unlikely that growth would elevate the spire to the extent developed in that species.

Localities and stratigraphical position.—Wyro, near Ulladulla; Ulladulla; Ulladulla Mudstone, Shoalhaven (Upper Marine) Group. Gerringong; Westley Park Tuff, Gerringong (Upper Marine) Volcanics. Rylstone; Capertee (Upper Marine) Group. Muswellbrook; Branxton Sub-group, Maitland (Upper Marine) Group.

Genus **Platyschisma** M'Coy 1844

Type Species: By subsequent designation of De Koninck, 1881: 107, *Ampullaria helicoides* J. de C. Sowerby, 1826.

Remarks.—The genus *Platyschisma* M'Coy is represented by moderately large globular shells, narrowly phaneromphalous, with a low spire, a large body whorl and a notchlike sinus in the upper half of the lip. In the past the Permian gastropods from New South Wales recognised as belonging to this genus consisted of *Platyschisma oculus* (Sowerby), *P. depressum* Dana = *P. allandalensis* Mitchell, *P. rotundatum* Morris, and *P. rotundatum* var. *farleyensis* Etheridge.

It was suggested by Etheridge (1902: 199) that *P. depressum* Dana has closer affinities with his genus *Keeneia* than with *Platyschisma*. It is quite distinct from the typical species of *Keeneia* and has been placed in the genus *Planikeeneia*, erected for depressed shells of this type.

As already mentioned in this paper *Platyschisma oculus* (Sowerby) is now referred to the genus *Keeneia*, while *P. rotundatum* var. *farleyensis* Etheridge is tentatively placed with *Planikeeneia occasa* sp. nov.

It is considered that *Platyschisma rotundatum* Morris is a doubtful representative of the genus *Platyschisma* M'Coy 1844, as defined by the genotype. Unfortunately, although the species is fairly abundant, very few specimens are well preserved and many characters, particularly those of the aperture, are not exhibited. Morris (1845: 286) mentioned that an ill-defined sinus is developed in the outer lip. In general form and particularly in the rounded profile of the whorls the shells are not unlike those of *Platyschisma* and until further complete specimens may prove otherwise, the species is retained in that genus.

A second and much smaller species from the Elderslie Formation of the Branxton Sub-group, Maitland (Upper Marine) Group of the Hunter River Valley, is also referred to the genus as *Platyschisma branxtonensis* sp. nov.

Platyschisma rotundatum Morris

(Pl. 16, figures 6—9)

Platyschisma rotundatum Morris, 1845: 286, pl. xviii, figure 2.

Platyschisma rotundatum M'Coy, 1847: 306.

Platyschisma rotundatum Dana, 1849: 707.

Platyschisma rotundatum Plews, 1858: pl. 4. (non) *Platyschisma rotunda* Etheridge, 1892: 286, pl. xv, figure 6.

Platyschisma rotundatum Etheridge, 1919: 188.

Holotype (by monotypy): Specimen figured by Morris 1845, pl. xviii, figure 2, from ? Harper's Hill, Allandale Formation, Dalwood (Lower Marine) Group. Collection of British Museum.

Description.—Large turbiniform, widely phaneromphalous gastropods of five whorls, a moderately low spire; whorls inflated and a large body whorl with a shallow ill-defined sinus in the outer lip; whorl profile gently arched between sutures, rounded on the body whorl with a slight depression below the upper suture; sutures fine, shallow; base broadly rounded; outer lip with a very shallow sinus at the periphery of the whorl, not culminating in a slit or notch; the margin of the lip gently convex forward with a backward obliquity to the sinus, continuing straight below the sinus to the umbilicus; ornamentation fine transverse growth lines with very characteristic thickenings of the shell; in steinkerns these are represented by very distinct transverse sulcations; no indication of revolving striae.

Dimensions.—

	F.45323	F.2192	F.29925
Height	48·5 mm	49 mm§	39 mm
Width	60 mm	63 mm	55 mm
Pleural angle	90°	101°	103°

§ Estimated

Remarks.—Morris (1845: 286) introduced this species for shells rather similar to *Platyschisma oculus* (Sowerby), but differing in having distinctly rounded whorls, an ill-defined sinus in the outer lip and " the inner part of the outer lip appears to have been periodically thickened, leaving deep sulcations in the cast of the shell ". He recorded it as abundant at Harper's Hill in the Allandale Formation of the Dalwood (Lower Marine) Group. In the light of our present knowledge this occurrence is surprising as the form now recognised as *Platyschisma rotundatum* Morris, is apparently restricted to rocks of the Gerringong (Upper Marine) Volcanics, the Shoalhaven (Upper Marine) Group, and their equivalents.

M'Coy (1847 : 306) listed the species as abundant at Harper's Hill, occurring in a dark aranaceous limestone. The species was also listed by Dana (1849 : 707), with a comment that it is " not uncommon in the sandstone at middle and southern Illawarra ", referring no doubt to Wollongong and Gerringong.

The species is represented in the collection by a large series of specimens, mainly steinkerns, from various localities on the South Coast, at Rylstone, and at Branxton and Muswellbrook in the Hunter River Valley.

This species has not been recognised by me from Harper's Hill and in my opinion the holotype figured by Morris (1845 : pl. xviii, figure 2) is a typical shell from Wollongong. An examination of this specimen in the British Museum collection may indicate its true locality.

The species is a characteristic one and Etheridge (1919 : 188) briefly stated its characters as : " The body whorl is distinctly rounded, or convex, above and below, there is no peripheral angle, or keel, and the inner part of the outer lip appears to have been periodically thickened leaving sulcations in the cast ". It has a superficial resemblance to *Walnichollsia subcancellata* (Morris) as both species have rounded somewhat inflated whorls and a moderately erect spire. It is readily distinguished from that species by the characteristic transverse sulcations, more rounded whorls and absence of strong spiral costae, crossed by finer transverse lirae, forming a lattice structure.

Localities and stratigraphical position.—? Harper's Hill; Allandale Formation, Dalwood (Lower Marine) Group. Grasstree, near Muswellbrook; Belford Formation, Branxton Sub-group. Branxton; Elderslie Formation, Branxton (Upper Marine) Sub-group. Wollongong, Gerringong, Kiama; Gerringong (Upper Marine) Volcanics. Wyro, near Ulladulla, Jervis Bay; Shoalhaven (Upper Marine) Group. Rylstone; Capertee (Upper Marine) Group.

Platyschisma branxtonensis sp. nov.

(Pl. 16, figures 1—3)

Holotype : Specimen No. F.28297, from Aberdare, 1 mile west of Cessnock; Elderslie Formation, Branxton (Upper Marine) Sub-group.

Paratypes : Specimens No. F.28294, from Aberdare and F.28305 from Branxton, near Maitland; same locality horizon as holotype.

Description.—Medium sized turbiniform gastropods, moderately low-spired of five inflated whorls, apex somewhat pointed; narrowly phaneromphalous; a possible wide shallow sinus in the outer lip (not observed), without slit or selenizone; whorl profile rounded with a slight shoulder developed below the upper suture; whorls closely impressed against preceding ones; sutures narrow, shallow; base convex; parietal lip seemingly wide, flattened and parietal inductura moderately thick; other apertural characters not preserved; ornamentation exceedingly fine numerous, transverse lirae, gently arched, almost straight, directed obliquely backward to the lower suture; lirae on body whorl periphery forming a wide shallow sinus, possibly indicative of the sinus on the outer lip; below the periphery the lirae extend straight into the umbilicus where they are closely packed; moderately sharp growth lines occasionally interpolated; aperture transversely oval.

Dimensions.—

	Holotype F.28297	Paratype F.28294
Height	29.5 mm	30 mm
Width	39.5 mm	37 mm
Pleural angle	96°	96°

Remarks.—This species bears a very close resemblance to *Platyschisma rotundatum* Morris although very much smaller and not possessing the very distinct transverse sulcations of that species The closely crowded fine lirae, backwardly directed at the periphery of the body whorl, is a characteristic feature. There are also faint indications of very occasional spiral costae, particularly on the holotype.

Localities and stratigraphical position.—Aberdare, 1 mile west of Cessnock; Branxton; Elderslie Formation, Branxton (Upper Marine) Sub-group.

Super-Family **Euomphalacea**

Family **Straparollidae**

Genus **Paromphalus** Grabau, 1936

Paromphalus ammonitiformis (Etheridge)

(Pl. 21, figures 1—5)

Straparollus ammonitiformis Etheridge, 1902 : 200, pl. xxxiii, figures 1—2.

Holotype (by monotypy) : Specimen No. F.7669, figured by Etheridge; Duguid's Hill, near Harper's Hill, Hunter River Valley, New South Wales. Allandale Formation, Dalwood (Lower Marine) Group. Australian Museum Collection.

Description.—Shell discoidal of five whorls; apex flat, depressed below level of body whorl, widely phaneromphalus. Sutures moderately deep. Whorl profile straight at the suture, broadly curved to periphery where there is a faint trace of a sinus; lower half similarly curved. No trace of a slit-band or selenizone; a faint pseudo-keel developed at the angle of the lirae on the periphery. Aperture elongate-oval, transverse. Ornamentation numerous fine transverse lirae (10—12 in 5 mm), and growth lines extending obliquely backwards to the periphery where they reverse direction at an acute angle to form a forwardly directed broad curve to the wide umbilicus. Shell moderately thick.

Dimensions.—

	Holotype	Plesiotypes	
	F.7669	F.28302	F.30018
Height	20 mm	12 mm	33 mm
Width	70 mm	34 mm	102 mm

Remarks.—Etheridge (1902 : 200) in describing *Straparolus ammonitiformis* referred it to the depressed section of the genus as characterised by *S. aequalis* Sowerby. The genotype of the genus is *S. dionysii* Montfort 1810 a trochiform gastropod with a wide, deep umbilicus and an obscure, broadly rounded revolving ridge on the upper whorl surface. Knight (1934 : 144) summarized the characters of Palaeozoic Euomphalidae and concluded that the species fell into two sub-groups *Straparolus* (ss) and *Euomphalus*. The sub-group *Straparolus* (ss) included those shells, grouped around *S. dionysii* Montfort, with a relatively high spire and rounded or only slightly shouldered whorls.

It is difficult to reconcile the characters of *Straparolus ammonitiformis* Etheridge, with those of *Straparolus* as defined by Knight. The Australian shell is discoidal with a very depressed flat spire, a wide shallow umbilicus and rounded whorls with no trace of shouldering.

Grabau (1936 : 302) introduced a new genus *Paromphalus* for planispiral gastropods in which the whorls are in contact, but not impressed; circular or oval in section, smooth and non-carinate. The apertural margin is uniform and rarely faintly sinuous. The single species of the genus is *P. mapingensis*, a small form with a maximum width of 21.8 mm, from the Lower Permian of China.

The characters of the Australian species, *Straparolus ammonitiformis* Etheridge, agree so perfectly with those of *Paromphalus* that it is considered its relationship is more with that genus than with *Straparolus*.

Since Etheridge (1902 : 200) described his species from a single specimen, two additional shells have come to hand from the same formation and very close to the type locality. These show a great variation in size, one specimen (F.28302) has a diameter of 34 mm, while the other (F.30018) has a diameter of 102 mm.

Etheridge in his original description stated that " one more whorl certainly existed than those shown in the illustration . . . ". This is not the case as what Etheridge thought was the line of junction of another whorl is simply a discoloration of the steinkern and was most likely caused by the differential weathering of the shell material.

Locality and stratigraphical position.—Duguid's Hill, near Harper's Hill; Harper's Hill. Allandale Formation, Dalwood (Lower Marine) Group.

Super-Family **Bellerephontacea**

Family **Bellerephontidae**

Genus **Warthia** Waagen, 1880

Types Species : *Warthia brevisinuata* Waagen 1880, Nila Wan ravine, Salt Range, India. Lower Productus Limestone, Permian.

Remarks.—There can be little doubt regarding the congeneric affinities of the three Australian species of this form with the genus *Warthia* as defined by Waagen. That author considered the Australian shells undoubtedly belonged to his genus although they were specifically different from the Salt Range species.

The genus consists of " smooth globular shells without slit-band and a broad tolerably deep sinuosity on the outer lip as in *Platyschisma*; inner lip only very slightly callous. No spiral sculpture ".

Warthia micromphala (Morris)

(Pl. 16, figures 4—5)

Bellerephon micromphalus Morris, 1845 : 288, pl. xviii, figure 7.

Bellerephon undulatus Dana, 1847 : 150.

Bellerephon undulatus Dana, 1849 : 706, pl. x, figures 4a, b.

Goniatites micromphalus Koninck, 1877 : (non Romer 1850), pl. xxiv, figures 5, a.

Warthia micromphala Reed, 1932 : 69, pl. xii, figures 12—14.

Holotype (by monotypy): Specimen figured by Morris 1845, pl. xviii, figure 7, from Illawarra. Gerringong (Upper Marine) Volcanics. Collection of the British Museum.

Description.—Deeply involute, anomphalous spiral gastropods of medium size; moderately wide and deep sinus in the anterior lip not developing into a slit or band; whorl profile narrowly rounded dorsally, gently arched laterally; peristome thickened, slightly expanded; lateral margins of aperture moderately convex forward as rounded lobes on each side of sinus; columella lips gently convex backward, partly covering a minute umbilicus; aperture semi-lunate, somewhat elongate, not widely expanded; ornamentation indistinct fine growth lines, occasionally interrupted by moderately wide transverse ridges following the line of growth. Shell thin.

Dimensions.—

	F.7937	F.8174
Greatest diameter	20.5 mm	23 mm
Width at umbilicus	8 mm	9 mm
Width at aperture...	11.5 mm	14 mm
Height of aperture from whorl	8 mm	8 mm

Remarks.—This species was originally described and figured by Morris (1845: 288) from the Illawarra district as *Bellerephon micromphalus*. He mentioned the presence of " slightly elevated ridges on the surface curving backwards from the minute umbilicus ". As foreshadowed in an earlier paper (Teichert and Fletcher 1943: 156) the specimen figured by Morris (1845: pl. xviii, figure 7) is quite unlike what was later to be considered a typical shell of that species.

In the Permian rocks of New South Wales there are found three distinct species of involute shells which belong to the genus *Warthia* Waagen 1880, namely, *W. undulata* (Dana), *W. stricta* (Dana) and *W. micromphala* (Morris). The specimen of the last mentioned species described and figured by Dana (1849: pl. x, figures 6a, b) is not conspecific with that figured by Morris (1845: pl. xviii, figure 7), and yet it is the form generally accepted as *Warthia micromphalus* (Morris).

It is considered that *Bellerephon micromphalus* of Morris 1845, is conspecific with the species described and figured by Dana (1849: 706, pl. x, figures 4a, b) as *Bellerephon undulatus*. The transverse ridges, a varying character in the species, are less defined on the body of the shell figured by Morris (1845: pl. xviii, figure 7) although one is represented at the peristome giving it the characteristically thickened appearance of the species. The general appearance, and particularly the shape of the aperture, are identical.

The holotype of *Warthia undulatus* (Dana) is recorded from Harper's Hill in rocks of the Dalwood (Lower Marine) Group. This specimen, figured by Dana, is a typical example of a shell from Wollongong and it is suggested that an error in labelling has occurred. His other two species of the genus are from Illawarra and furthermore I have never seen this species at Harper's Hill or in collections from that locality.

A great deal of uncertainty has long existed regarding the status of " *Bellerephon micromphalus* Morris " and at different times the species has been referred by different authors to such genera as *Goniatites, Warthia, Agathiceras, Prolecanites, Paralegoceras* and others. The history of " *Bellerephon micromphalus* " has been mentioned earlier in this paper and is also dealt with more completely in an earlier paper (Teichert and Fletcher 1943: 156). There is no necessity for it to be repeated here.

In *Warthia micromphala* (Morris) (non *Bellerephon micromphalus* Dana), there is a considerable amount of variation in the strength and number of the transverse ridges on the dorsal and lateral surfaces of the shells. A ridge usually is developed at the peristome giving it a rather thickened and campanulate appearance.

Koninck (1877: 339) in describing this species as *Goniatites micromphalus* (Morris), remarked that *Warthia undulatum* (Dana) is only a *W. micromphalus* (Morris) with more pronounced " furrows ". This is correct as he was comparing Dana's species with that of Morris's, forms which are conspecific, and not with *W. micromphala* (Dana) an entirely different species.

The species recorded by Reed (1932: 69) as *Warthia micromphala* (Morris), from the Agglomeratic Slate of Kashmir, could very well belong to this species. The specimen figured by him (1932: pl. xii. figure 14) shows the transverse ridges, while the smoother examples (figures 12—13) show only one apparent difference in the greater depth of the sinus. Foord (1890: 104) recorded *Warthia micromphala* (Morris) from the Permian of Western Australia and Reed (1930: 43) recorded it doubtfully from Brazil. In both these cases it would be necessary to examine actual material before the true status of the forms could be decided.

Etheridge (1880: 304) and (1892: 294—5) recorded this species from Permian rocks at the head of Pelican Creek, in the Bowen River district of Queensland, as *Goniatites micromphalus* (Morris). He pointed out that his specimens differed from " *Bellerephon micromphalus* Morris, in that the depth of the body whorl near the mouth is not so great, but they agreed with Dana's figure of " *Bellerephon*

micromphalus". As already pointed out these two forms are distinct species and it would appear that the Queensland shells are examples of *Warthia perspecta* sp. nov., a species introduced in this paper for shells as defined and named by Dana (1849 : 708, pl. x, figures 6a, b) as *Bellerephon micromphalus* (non *B. micromphalus* Morris 1845).

Shells of *Warthia micromphala* (Morris) are fairly abundant in rocks of the Gerringong (Upper Marine) Volcanics at Wollongong on the South Coast. It is also abundant in the Hunter River Valley at Ravensfield, where it occurs in the Ravensfield Sandstone at the base of the Farley Formation of the Dalwood (Lower Marine) Group. Occasional poorly preserved specimens have been collected from rocks of the Branxton Sub-group in the Hunter River Valley and its equivalent (in part), the Shoalhaven (Upper Marine) Group of the South Coast.

Localities and stratigraphical positions.—Wollongong; Gerringong; Gerringong Volcanics. Ravensfield; Ravensfield Sandstone, base of Farley Formation, Dalwood (Lower Marine) Group; Harper's Hill (doubtful locality); Dalwood Group. Muree; Branxton Sub-group, Dalwood Group.

Warthia perspecta sp. nov.

(Pl. 15, figures 3—10)

Bellerephon micromphalus Dana (non *B. micromphalus* Morris 1845), 1849 : 708, pl. x, figures 6a, 6b.

Goniatites micromphalus Etheridge, 1880 : 304.

Goniatites micromphalus Etheridge, 1892 : 294—5.

Goniatites (*Prolecanites* ?) *micromphalus* Etheridge (in part), 1894 : 36, pl. vii, figures 10—11 (non figures 9, 12, 13, 14).

Holotype : Specimen figured by Dana (1849, pl. x, figures 6, 6a) as *Bellerephon micromphalus*, from the Illawarra District. Gerringong (Upper Marine) Volcanics. Collection of the United States National Museum, Washington.

Description.—Moderately large, deeply involute, inflated, anomphalous, spiral gastropods with a wide moderately shallow sinus in the anterior lip and not developing into a notch or band; whorl profile rounded; peristome thin, very slightly reflexed; lateral margins of aperture concave backwards at umbilicus, gently arched forward in the form of lobes on each side of the sinus; aperture lunate, expanded with moderately wide side extensions; ornamentation indistinct fine transverse, broad, V-shaped, growth lines; shell thin.

Dimensions.—

	F.39686	F.7931	L.695‖	F.35733¶
Greatest diameter	29 mm	34.5 mm	27 mm	26 mm
Thickness at umbilicus	12 mm	16 mm	11 mm	12 mm
Width at aperture...	18.5 mm	20.5 mm	17 mm	16.5 mm

‖ Plastotype of specimen figured by Dana (1849; pl. x, figs. 6a, 6b).

¶ Specimen figured by Etheridge (1894; pl. vii, fig. 10.)

Remarks.—This is a very distinct and easily recognised species and is represented in the collection by a large series of specimens. It is distinguished from *Warthia micromphala* (Morris) by its distinctly rounded and more inflated appearance. The aperture is lunate and wide and the sinus in the anterior lip is wide and shallow.

Dana (1849 : pl. x, figures 6a, b) figured a specimen which he considered to be conspecific with *Bellerephon micromphalus* Morris 1845. His only remarks were (p. 708) : "This species, like the preceding (*B. strictus* Dana) has the aspect of a goniatite. It differs from *B. strictus* in being proportionately much thicker". The specimen came from Illawarra.

As mentioned earlier in my discussion on *Warthia micromphala* (Morris), the specimen figured by Dana is distinct from the shell figured by Morris (1845 : pl. xviii, figure 7). Morris's specimen is not nearly as inflated, the aperture is elongate and narrow and a side view shows a distinct transverse groove and a ridge forming a thickened anterior lip. Morris also remarked on the presence of "a deep sinus in front". These characters are all consistent with those of Dana's *Bellerephon undulatus*, now *Warthia micromphala* (Morris), and the two forms are without doubt conspecific.

The specimen figured by Dana (1849 : 708, pl. x, figures 6, 6a) as *Bellerephon micromphalus* Morris is without a name and is described as *Warthia perspecta* sp. nov.

This species is abundant at Wollongong, on the South Coast, and also at Ravensfield in the Hunter River Valley, where it is associated at both localities with *Warthia micromphala* (Morris). The shells attain considerable size and become very inflated.

Localities and stratigraphical positions.—Wollongong; Gerringong; Jamberoo; Gerringong (Upper Marine) Volcanics. Bundanoon. Rylstone; base of Capertee (Upper Marine) Group. Ravensfield; Ravensfield Formation, Dalwood (Lower Marine) Group. Farley; Elderslie Formation, Branxton (Upper Marine) Sub-group. Muree; Belford Formation, Branxton Sub-group.

Warthia stricta (Dana)

(Pl. 15, figures 11—14)

Bellerephon strictus Dana, 1847 : 150.

?*Bellerephon contractus* Jukes, 1847 : 242. (nom. nud.)

Bellerephon strictus Dana, 1849 : 707, pl. x, figures 5a, b.

?*Goniatites strictus* Koninck, 1877 : 341.

Holotype (by monotypy) : Specimen figured by Dana (1849 : pl. x, figures 5a, 5b) as *Bellerephon strictus*, from Wollongong. Gerringong (Upper Marine) Volcanics. Collection of the United States National Museum, Washington.

Remarks.—Moderately small, deeply involute, compressed, anomphalous, spiral gastropods; moderately deep and narrow V-shaped sinus in the anterior lip, not culminating in a band; whorl profile narrowly rounded, almost dorsally ridged, gently arched to flattened laterally; aperture elongate, its lateral margins closely pressed against preceding whorl near umbilicus; sloping obliquely forward and inward to sinus into which it abruptly curves; an occasional ill-defined transverse groove following the lines of growth; shell thin; ornamentation unknown.

Dimensions.—

	F.1081	L.701**
Greatest diameter	21.5 mm	21 mm
Thickness at umbilicus	9 mm	10 mm
Width at aperture...	11 mm	11 mm
Height of aperture from whorl	9 mm	7 mm

** Plastotype of specimen figured by Dana (1849; pl. x, figs. 5a, b.)

Remarks.—Dana (1847 : 150) described this species from Wollongong as " a discoid, much compressed form in which the aperture is narrow-compressed-lunate, not dilated ". In 1849 (p. 707) he figured a specimen of the species without any additional comments.

Koninck (1877 : 341) described a very compressed form as this species and referred it to the genus *Goniatites*. He records his specimen from a black limestone at Harper's Hill, whereas the only other known material is from much higher beds in the Permian sequence at Wollongong and Gerringong, Koninck's specimen represents a very compressed form with a diameter of 11 mm, and a thickness of 5 mm. It is doubtful whether his form is conspecific with *W. stricta* (Dana). His material was subsequently destroyed in the Garden Palace fire at Sydney, in 1882.

In listing a collection of fossils from Wollongong, (identified by J. Sowerby), Jukes (1847 : 242) included *Bellerephon contractus* MSS. The species was never described, but as its name implies a shell with contracted sides it has been placed in the synonomy of *W. stricta* (Dana).

This species is rare in comparison with *W. micromphala* (Morris) and *W. perspecta* sp. nov. It is readily distinguished from them by its laterally compressed sides, elongate and narrowed aperture, and moderately deep, narrow sinus.

Localities and stratigraphical position.—Wollongong; Gerringong. Gerringong (Upper Marine) Volcanics. ? Harper's Hill. Dalwood (Lower Marine) Group.

THE LIMITS OF PERMIAN ROCKS IN NEW SOUTH WALES

It is now generally accepted that the complete sequence of rocks in the Hunter River Valley passes upward from the basal Lochinvar glacial beds to the Newcastle Coal Measures which are overlain by the Triassic Narrabeen Series.

The use of the term Permo-Carboniferous was introduced into Australian geology by Etheridge in 1880 and it then came into general use for the above succession of rocks. Previous to this the " Upper Coal Measures " were referred to as being of Permian age, while the " Upper Marine Series ", the " Lower Coal Measures " and the " Lower Marine Series " were considered to be of Upper Carboniferous age.

It was suggested later that if the Kuttung Series, underlying the Permian sequence in the Hunter Valley, was of Middle Carboniferous age then we should look to the lowest beds of the " Lower Marine Series " for sediments of Upper Carboniferous age. It was considered by some authors that certain faunal elements in the lower part of the " Lower Marine Series " had Upper Carboniferous affinities and because of this the name Kamilaroi was introduced by David in 1931 to include all Permo-Carboniferous sediments above the base of the Allandale Formation. The Lochinvar Formation was thus considered to be of Upper Carboniferous age.

It was proved conclusively that there is no palaeontological evidence to support a separation of the " Lower Marine Series " into Upper Carboniferous and Lower Permian or Kamilaroi (Raggatt and Fletcher 1937). The fossil fauna of the Lochinvar Formation has strong affinities with the undoubted Permian and practically none with the Upper Carboniferous. The entire marine fauna of Dalwood (Lower Marine) Group, the Maitland (Upper Marine) Group and their equivalents are therefore of Permian age.

STRATIGRAPHY AND GASTROPOD FAUNA OF THE PERMIAN IN NEW SOUTH WALES

The Hunter River Valley Area

The complete sequence of Permian rocks in the Lower Hunter Valley has a total thickness of approximately 17,000 ft. Many exposures of marine sediments are found containing an abundant and representative fauna.

The sequence of the Permian rocks in the Lower Hunter River Valley, with revised nomenclature, is as follows :—

Group	Formation	Lithology
	ft.	
Newcastle Coal Measures	1,200	Conglomerate, sandstone shale and coal seams.
Tomago Coal Measures...	1,860	Shale, sandstone and coal seams.
Maitland (Upper Marine) Group — Mulbring Sub-Group ...	1,200	Shales and shaly mudstones. (†† at base).
Maitland (Upper Marine) Group — Branxton Sub-Group— Muree	200	Sandstone and sandy mudstone, calcareous in part.††
Maitland (Upper Marine) Group — Belford	1,450	Essentially sandy shales.††
Maitland (Upper Marine) Group — Fenestella Shale ...	20—100	Yellowish shales with abundant *Fenestella*.††
Maitland (Upper Marine) Group — Elderslie	1,450	Sandstones and sandy shales with massive basal sandstone.††
Greta Coal Measures	200	Fine conglomerate, sandstone, shale and coal seams.
Dalwood (Lower Marine) — Farley	985	Sandy shales and mudstones. Ravensfield Sandstone (200 ft) at base. (†† top).
Dalwood (Lower Marine) — Rutherford	1,170	Sandy shales, shales and mudstones.
Dalwood (Lower Marine) — Allandale	1,000	Mainly calcareous mudstones. Allandale Conglomerate at base.
Dalwood (Lower Marine) — Lochinvar	2,600	Shales, mudstones, sandstones, amygdaloidal basalt, reddish-brown shale at base. (†† base).

†† — Distribution of erratics.

Hunter River Valley

In the Hunter River Valley both the Maitland and Dalwood Groups attain their greatest development in the lower part of the valley and then thin rapidly to the north and to the west.

The fauna of the Dalwood (Lower Marine) Group and the Maitland (Upper Marine) Group of the Hunter River Valley and their equivalents in New South Wales, present strong affinities with beds of similar age in Tasmania and Queensland, but to a lesser extent in Western Australia.

A study of the Permian gastropods of New South Wales has indicated very clearly the presence of two outstanding zones, or life horizons, with a considerable development of species and with abundant representation.

The older of the two zones is represented at Harper's Hill, where in the Allandale Formation a rich gastropod fauna occurs in an andesitic tuff overlying the Allandale Conglomerate. The shells are beautifully preserved with excellent ornamentation.

The gastropods mainly restricted to the Allandale Formation at Harper's Hill and its equivalents are:

Keeneia platyschismoides Etheridge
Keeneia trochiforme sp. nov.
Cycloscena anomphala gen. et. sp. nov.
Planikeeneia insculpta gen. et. sp. nov.
Planikeeneia depressum (Dana)
Planikeeneia minor sp. nov.
Paromphalus ammonitiformis (Etheridge)
Pleurocinctosa allandalensis gen. et. sp. nov.
Rhabdocantha alta (Dana)
Rhabdocantha cornucapella sp. nov.
Rhabdocantha adunca sp. nov.
Rhabdocantha intermedia sp. nov.
Rhabdocantha irregularis sp. nov.
Rhabdocantha ungula (Etheridge)

The shells of *Keeneia platyschismoides* and *Keeneia trochiforme* are fairly abundant and of large size. Johnston (1888 : pl. xviii, figure 4) illustrated a gastropod from the Huon Road, near Hobart, Tasmania, as *Platyschisma ocula* (Sowerby), which from the figure appears to be conspecific with *K. trochiforme*. In a recent communication, Mr. M. Banks, of the University of Tasmania, informed me that the Huon Road beds are in his opinion equivalent, in part, with the Berridale Limestone of that State and possibly with some part of the Maitland (Upper Marine) Group, possibly the Branxton Subgroup, of the Hunter River Valley. This species is apparently restricted to the Allandale Formation in New South Wales and further information regarding its exact relationship with the Tasmanian shell will be of interest. Other restricted species found at Harper's Hill consist of *Cycloscena anomphala* gen. et. sp. nov., an outstanding thick-shelled form; *Paromphalus ammonitiformis* (Etheridge), and small shells of *Planikeeneia minor* gen. et. sp. nov., and *P. insculpta* sp. nov.

Dun (1913 : 8) described a moderately small shell from the Tasmanite Spore Beds of the Mersey River, Tasmania, as *Keeneia twelvetreesi*. The holotype of this species is missing, but the description and illustration indicates a very close relationship to *Planikeeneia insculpta* sp. nov., from Harper's Hill. I am informed by Mr. Banks that the Tasmanite beds, originally thought to be equivalent, in part, to the Maitland (Upper Marine) Group, is now considered by him to be probably equivalent to some horizon low in the Dalwood (Lower Marine) Group of the Hunter River Valley. Miss I. Crespin, Commonwealth Palaeontologist, Mineral Resources Bureau, recently found that the foraminifera of the beds supported this correlation.

Gastropods of the genus *Rhabdocantha* are comparatively rare in the Allandale Formation at Harper's Hill and except for a specimen of *R. alta* (Dana), doubtfully recorded from Ulladulla, (Shoalhaven Group), have not been found elsewhere.

Other species described from Harper's Hill, but not restricted to that locality, include *Keeneia ocula* (Sowerby) and *Pleurocinctosa allandalensis* gen. et. sp. nov. The former species is abundant at Harper's Hill, but ranges through the sequence in diminished numbers both in the Hunter Valley and the South Coast. It regains its numbers temporarily in the Gerringong Volcanics at Wollongong and Gerringong. It is also plentiful at Rylstone in the Capertee Group.

A poorly preserved gastropod from an interesting fossil occurrence on the slopes of Loder's Mountain, about seven miles east of Willow Tree, was identified by me and listed (Hanlon 1948a : 289) as *Platyschisma ocula* (Sowerby). A re-examination of the specimen showed it to be slightly larger than typical examples of *Keeneia ocula* (Sowerby), but agrees well with shells from Harper's Hill.

The Loder's Mountain fossil locality occurs in the top of the Lower Stage of the Willow Group, which Hanlon (1948a : 288) considers, with the Werrie Stage, is the equivalent of the Dalwood Group of the Hunter River Valley. *Eurydesma* is also found at Loder's Mountain, but as it is now known to occur in zones both in the Maitland and Dalwood Groups, its presence in the Lower Stage of the Willow Group is not in itself evidence of Dalwood age.

The Upper Stage of the Willow Group is correlated with the Greta Coal Measures while the overlying Borambil Group is considered the equivalent, in part, with the Tomago Coal Measures and the Mulbring Formation. Fossils from the Lower Stage of the Borambil Group, identified by me, were recorded by Hanlon (1948 : 282).

A zone of calcareous shale, about 9 in thick, found in the road cutting at Harper's Hill, is literally crowded with the small turreted shells of *Pleurocinctosa allandalensis* gen. et. sp. nov. This species first appears in the underlying Lochinvar Formation, where in shales about 1,280 ft from the base of the Dalwood Group it is found in abundance.

In the Manning-Macleay Province, on the North Coast of New South Wales, *Pleurocinctosa allandalensis* is fairly abundant in the Pecten Sandstone and Mudstone Horizon of the Tait's Creek Formation at Yessabah, and in the Linoproductus Horizon of the Warbro Formation at Kimbriki on the Manning River. The shells of the species are very similar to those from the type locality except for a slightly heavier ornamentation.

The Permian rocks of the Manning-Macleay Province consist of nearly 3,000 ft of sediments and are known as the Macleay Group. Voisey (1951 : 64) divided the group into three formations which, in descending order, are the Warbro Formation, 1,640 ft, the Yessabah Formation, 1,260 ft, and the Tait's Creek Formation, 500 ft. He stated that there were certain similarities in the strata and fauna with the Dalwood Group of the Hunter Valley and that the two sequences are of the same general age. The occurrence of *P. allandalensis* in the Warbro and Tait's Creek Formation indicates a correlation with the Allandale and Lochinvar Formations. A complete list of the abundant and fairly comprehensive fossils of the Macleay Group determined by me is given in two papers by Voisey (1936, 1939a).

It is the opinion of Voisey (1951 : 67) that the absence of *Linoproductus springsurensis* (Booker) and *Cladochonus nicholsoni* (Etheridge) in the Hunter Valley sequence and their abundance in the Manning-Macleay Province suggests a land barrier south of the Manning River. There is a surprising absence in the Macleay Group of the unique and abundant gastropod fauna of the Allandale Formation.

A single specimen (a mould) from Portions 195 and 196, Parish Curlewis, County Pottinger, in the Gunnedah-Curlewis district (Hanlon 1949 : 244) was incorrectly identified by me as *Ptychomphalina morrissiana* M'Coy. The specimen possibly represents a new genus and species, but is insufficiently preserved for description. It is slightly larger than typical specimens of *Pleurocinctosa* and has definite spiral ornamentation. A comprehensive series of fossils from the same locality and recorded by Hanlon (1949 : 244—5) is characteristic of the Maitland Group. *Terrakea* and *Strophalosia* are the dominant genera.

Marine sediments in the Gunnedah-Curlewis district are represented by the Porcupine Formation, the equivalent possibly of the Mulbring Formation or the higher part of the Branxton Sub-Group. The overlaying Gladstone Formation is also considered by Hanlon (1949 : 245) to be possibly the equivalent in part of the Maitland Group. Marine deposits of Dalwood age are not found in the Gunnedah-Curlewis area.

In the Narrabri district the Permian rocks consist of the Greta Coal Measures and the Maitland Group. Hanlon (1950 : 304) named the marine sediments the Barra Group. Fossils are known from three localities, the most important being an outcrop in Portion 80, Parish Eulah, from which Dun (1909 : 190) recorded *Ptychomphalina*. Specimens of *Ptychomphalina morrissiana* M'Coy, now referred to *Pleurocinctosa trifilata* (Dana), were collected (Hanlon 1950 : 305) from Portion 78, Parish Eulah. Imperfect specimens of what is possibly this species are also recorded from Jeogla (Voisey 1950), and from the top of the Upper Division of the Drake Group in the Drake-Boorook district, a fairly high-spired form of the genus *Pleurocinctosa* is known from several moulds.

It is surprising that gastropods are so rare in the Permian rocks of the Drake-Boorook area. None has previously been recorded even though there is a great development of fossils in the Upper Division. These are recorded by Voisey (1936 : 160—164).

The Lower Division of the Drake Group consists mainly of volcanic rocks and marine fossils are found only in the andesitic and trachytic tuffs at the top of the sequence. Fossils are not abundant and the dominant genera are *Thamnopora* and *Cladochonus*.

The Drake Group is possibly the equivalent, in part, of the Maitland (Upper Marine) Group and the Dalwood (Lower Marine) Group of the Hunter Valley. Voisey (1936 : 164) suggests that the Silverwood Fault Block Group (Queensland), the Drake Group and the Macleay Group may in a broad sense be correlated with one another and all are considered by him to be of Dalwood age.

In the Breeza district, marine sediments are restricted to shales and interbedded limestones which have received the name Watermark Formation (Hanlon 1949 : 252). Fossils collected in the Parish of Breeza within Portion 144 and the south-western corner of Portion 155, include *Keeneia ocula* (Sowerby).

The involute gastropods of the genus *Warthia* occur in considerable numbers in the Ravensfield Sandstone which forms the base of the Farley Formation of the Dalwood Group. This horizon is only 15 to 20 ft thick and the abundant marine fossil fauna is restricted mainly to pebbly bands which occur through it. The dominant forms are a pelecypod, *Edmondia*, and *Warthia* spp., notably *W. micromphala*

(Dana) and *W. perspecta* sp. nov. These species then appear only sporadically through the sequence, but regain their numbers at Wollongong in the Gerringong Volcanics. An interesting occurrence of *Warthia perspecta* sp. nov., is near Farley, where two perfectly preserved specimens associated with a goniatite, *Adrianites* (*Neocrinites*) *meridionalis* Teichert and Fletcher, were collected from a few hundred feet above the base of the Branxton Sub-Group in the Elderslie Formation. Superficially the goniatite and the gastropods are identical, the former however, having ornamentation and suture lines.

The fossil fauna of the remainder of the Farley Formation contains forms characteristic of both the Dalwood and Maitland Groups and their equivalents. Gastropods are not plentiful and are usually of smaller size, a feature continuing to a great extent through most of the strata of the Maitland Group.

Cranky Corner Basin

The Dalwood (Lower Marine) Group at Cranky Corner is represented by 820 ft of sediments and, as pointed out by Booker, has thinned out in a distance of about 15 miles from Branxton from nearly 6,000 ft. The following section is as measured by Booker (1950) during a visit to the area with the author—

	ft.
Mudstones, sandstones and conglomerates...	300
Coarse tuffaceous sandstones containing marine fossils. (Eurydesma Horizon).	120
Bluish shaly mudstones with numerous marine fossils, chiefly Fenestellidae.	300
Coarse sandstones with plant remains	100

The Maitland Group has an approximate thickness of 300 ft consisting mainly of a hard massive sandstone, probably the equivalent of the Elderslie Formation of the Branxton Sub-Group. The only marine fossils so far found consist of several species of *Conularia*. Booker (1950) considers that the thickness of the Maitland Group at Cranky Corner as stated by Walkom (1913 : 151) and Raggatt (1938) is excessive. In his opinion the Muree Formation is absent or unrecognizable and the Mulbring Formation (Crinoidal Shales) is also not represented.

The Eurydesma Horizon and associated tuffs and sandstones are correlated with the Allandale Formation and the basal sandstones and contained fossil plants are thought to be the equivalent of that found at the base of Lochinvar Formation. The Eurydesma Horizon at Cranky Corner is an amazing example of an ancient shell-reef, consisting as it does of an almost solid mass of *Eurydesma* shells. Gastropods are well represented, but do not include the wide variety of species found at Harper's Hill. The horizon can be traced almost continuously round the Cranky Corner Basin.

Muswellbrook

At Muswellbrook the marine deposits are restricted to a thickness of from 1,263 to 2,635 ft and are representative of the Mulbring Formation and the Branxton Sub-Group. Marine fossils have been found in these rocks including specimens of *Eurydesma* from near the base of the Branxton Sub-Group indicating a correlation with the Eurydesma Zone at Wattle Ponds Creek and Loders' Dome. This zone is the Belford Formation of the Branxton Sub-Group. Gastropods from Muswellbrook have been identified as *Walnichollsia pygmaea* sp. nov., and *Platyschisma rotundatum* Morris, species also found in the Capertee Group of the Western Coalfield, the Shoalhaven Group and the Gerringong Volcanics of the South Coast district.

The Central Highlands

The marine sediments of the Maitland and Dalwood Groups of the Hunter River Valley thin very rapidly towards the west as well as to the north. Booker (1953 : 20) states that sediments referable to the Dalwood (Lower Marine) Group are not found beyond the Loder Bore, about 8 miles south-west of Singleton. The thinning of the Maitland (Upper Marine) Group continues through the valley of the Goulburn to the Western Coalfield in the Central Highlands where it is represented by the Capertee Group (Rayner and McElroy 1956).

This group is of varying thickness with a maximum thickness of about 500 ft and it has a wide horizontal distribution. The basal beds consist of a coarse conglomerate, in which a rich and interesting marine fauna is found at Rylstone where, north of the township, several outcrops rest unconformably on rocks of Upper Devonian age. The comprehensive nature of this fauna was not known until Mr. Walter Nicholls of Rylstone presented to the Australian Museum a large collection of fossils which he had collected during many years in the district. The dominant forms are mainly large species of pelecypods, gastropods and brachiopods. The only previous published record of Permian fossils from Rylstone is that of *Conocardium* (Fletcher 1943 : 231). Additional new species of pelecypods remain to be described and will be dealt with in a later paper.

The gastropods from Rylstone are—

Walnichollsia subcancellata (Morris)
Walnichollsia pygmaea sp. nov.
Platyschisma rotundatum (Morris)
Strotostoma rylstonensis gen. et sp. nov.
Strotostoma inflata sp. nov.
Mourlonopsis strzeleckiana (Morris)
Pleurocinctosa trifilata (Dana)
Warthia perspecta sp. nov.
Keeneia ocula (Sowerby)

Several other localities for marine fossils in the Western Coalfield have been recorded by Harper (1908: 61). The marine sediments at Rylstone appear to be the equivalent, in part, of the Branxton Sub-Group of the Hunter Valley, and the Gerringong Volcanics of the Illawarra District.

Burragorang Valley

In the past little attention has been devoted to the occurrence of Permian marine deposits in the Burragorang Valley. Recent field-work by officers of the Geological Survey of New South Wales has resulted in several localities being found where a comparatively rich fossil fauna is preserved. The marine horizon is about 120 ft thick and consists mainly of a silty sandstone interbedded with shale bands. The fossils, mainly pelecypods, occur almost exclusively in a basal bed of conglomerate.

Bundanoon Gully

An outcrop of marine rocks of Permian age is exposed in the Bundanoon Gully, 700 ft below the site of Tooth's old sawmill, 2 miles south of Bundanoon Railway Station. The rock is a fairly coarse, iron-stained conglomerate and is similar in lithology to the fossiliferous rocks of the Capertee Group at Rylstone. The fossils, including gastropods, indicate a correlation with the Rylstone beds and the Gerringong Volcanics.

The only extensive collection of fossils from Bundanoon Gully is one made in 1913 by the late Mr. W. W. Thorpe and now in the Australian Museum. Apart from a paper on some unique pelecypods (Etheridge 1918: 222) the fauna has received no attention.

The South Coast Province

Marine rocks of Permian age which are the equivalent, in part, of the Maitland (Upper Marine) Group are exposed as they emerge from below the Cumberland Basin, slightly north of Wollongong. The marine sediments are thereafter found outcropping on the coast south to South Durras where they rest unconformably on rocks of probable Ordovician age. They extend inland to the edge of the Southern Highlands where they outcrop on the Sassafras tableland 2,700 ft above sea-level.

Most of the numerous and extensive exposures of marine sediments are richly fossiliferous and contain a wide variety of species. Complete lists of fossils found at most of the localities in the South Coast Province have been recorded by Harper (1915).

In the Explanatory Notes to the Wollongong 4-mile sheet, published by the Bureau of Mineral Resources, Joplin, Hanlon and Noakes (1953) reviewed the Permian rock units of the Illawarra District as far south as Nowra. The complete sequence is given in detail with the exception of the Ulladulla Mudstone and the overlying Conjola Beds. These are the most southern outcrops.

The complete sequence, with the revised nomenclature as given by the above authors, is as follows:—

Group	Rock Unit
Gerringong Volcanics	Cambewarra Latite. Max. 600 ft. Marine fossils in tuff. Saddleback Latite. Max. 250 ft. Non-fossiliferous. Broughton Tuff— Jamberoo Tuff Member, 180—510 ft. Bumbo Latite, 30—500 ft. (non-fossiliferous). Kiama Tuff Member, 120 ft. Blow Hole Latite, 140 ft. (non fossiliferous). Westley Park Tuff Member, 40 ft. Broughton Tuff (undifferentiated in the south), 350—760 ft.
Shoalhaven Group	Berry Shale, 720 ft. Nowra Sandstone, 250 ft. Wandrawandian Siltstone, 550 ft. ‡‡Conjola " Beds ", 1,400 ft. ‡‡Ulladulla Mudstone, 100 ft.

‡‡ These two lower units of the Group are added to the sequence. The estimated thicknesses are as given by David (1950: 347).

The Gerringong Volcanics and the Shoalhaven Group are correlated with the Maitland Group of the Hunter River Valley, but correlation of the sub-divisions is still uncertain. The South Coast rocks show a marked contrast in lithology to those of the Hunter Valley. Conglomerates and glacial beds are not prominent, but shales and mudstones are most conspicuous with tuffs and lava flows well represented.

In the Wollongong area argillaceous sandstones and shales containing a rich fossil fauna are exposed at a number of localities. These may represent different horizons in the Jamberoo Tuff Member, although McElroy (unpublished thesis) has suggested a thickness of at least several hundred feet for one single fossiliferous horizon which has been traced to near the southern boundary of Lake Illawarra. The uppermost beds are characterised by numerous large pelecypods, including *Cleobis grandis* Dana, associated with other typical Permian species. Towards the base of these beds the genus *Terrakea* is dominant.

The underlying Kiama Tuff Formation is a distinct horizon only over the area of the Bumbo Latite. South and west it becomes incorporated in the Trachytic Tuffs. Although marine fossils have been collected from several localities near Kiama fossils are generally considered to be rare.

The Westley Park Tuff loses its tuffaceous character at about 40 ft below its surface and grades into argillaceous sandstones and shales. Fossils are plentiful and at Black Head, Gerringong, and other nearby localities a rich and varied fauna has been recorded by Harper (1950 : 107). A quarry near Broughton Village has yielded many well preserved specimens of brachiopods and pelecypods. Gastropods are represented by *Walnichollsia pygmaea* sp. nov., *W. subcancellata* (Morris), *Keeneia ocula* (Sowerby) and *Platyschisma rotundatum* Morris. The sediments possibly belong to the Westley Park Tuff.

It was pointed out earlier in this paper that a considerable development and variety of gastropods is very noticeable in the Allandale Formation, Dalwood (Lower Marine) Group, in the Hunter River Valley. A second enrichment of gastropods in the Permian sequence is found in the Gerringong Volcanics of the South Coast, the most important localities being Wollongong, Jamberoo and Gerringong. These gastropods are—

Walnichollsia subcancellata (Morris)

Walnichollsia pygmaea sp. nov.

Platyschisma rotundatum Morris

Mourlonopsis strzeleckiana (Morris)

Strotostoma rylstonensis gen. et sp. nov.

Keeneia ocula (Sowerby)

Pleurocinctosa trifilata (Dana)

Warthia stricta (Dana)

Warthia undulata (Dana)

Warthia perspecta sp. nov.

Planikeenia occasa sp. nov.

?*Planikeenia minor* sp. nov.

The above species resemble very closely those recorded from the Capertee Group at Rylstone and, to a lesser extent, those found in the Bundanoon Gully. It is suggested that the deposits at these three localities were laid down contemporaneously.

As mentioned earlier in this paper it is considered that *Mourlonopsis strzeleckiana* (Morris) and *Platyschisma rotundatum* Morris, in all probability do not occur outside the limits of the Maitland Group and its equivalents, even though they were recorded by early authors from the Allandale Formation at Harper's Hill. *Walnichollsia subcancellata* (Morris) and *W. pygmaea* sp. nov. are not uncommon in the Gerringong Volcanics, the Shoalhaven Group, the base of the Capertee Group, the Branxton Sub-Group and at Bundanoon, near Moss Vale. In the Branxton Sub-Group, both species have been collected at Branxton, possibly in the Elderslie Formation, and from the Belford Formation at Muswellbrook an incomplete shell is thought to be *N. pygmaea* sp. nov.

Strotostoma inflata gen. et sp. nov., and *S. rylstonensis* sp. nov., are found in the conglomerate of the Capertee Group at Rylstone, and the latter species is also represented in the Gerringong Volcanics, the Shoalhaven Group, and possibly the Muree Formation of the Branxton Sub-Group.

The bicarinate shells of *Pleurotomaria morrissiana* M'Coy, renamed in this paper as *Pleurocinctosa trifilata* (Dana), are found in a definite zone in the Westley Park Tuff at Gerringong where the rock is literally crowded with shells. The species is widely distributed, but is rather sporadic throughout the rest of the Maitland Group and its equivalents.

The rocks of the Shoalhaven Group on the South Coast, although rich in fossils, contain a rather poor and limited gastropod fauna. In most cases the specimens are poorly preserved steinkerns and definite specific determinations are difficult.

The Berry Shale, consisting mainly of grey shales and siltstones, is the topmost formation of the Shoalhaven Group. It overlies the Nowra Sandstone near Berry and is also found outcropping at Nowra Hill, south of Nowra.

The underlying Nowra Sandstone is found outcropping in the Nowra area. The boundary between it and the underlying Wandrawandian Siltstone has been only incompletely mapped, but it has been suggested that the Nowra Sandstone lenses out into siltstone on the coast south of the Shoalhaven River. Laseron (1910 : 196) states that it displays great difference from both of the other formations in the type of sediment and its contained fossil fauna.

The extent and knowledge of the boundaries of the Wandrawandian Siltstone is still mainly conjectural. In the vicinity of Tomerong and east to the north coast of Jervis Bay siltstones predominate. Laseron (1910 : 195) found that at Burrier, on the lower Shoalhaven River, a fossiliferous horizon is overlain by gritty sandstones and a series of finely laminated shales and sandstones all of which are barren of fossils. He is of the opinion that the Wandrawandian " Series " originated under littoral conditions and the beds as a result show considerable variation over short distances. A rich fossil fauna, mostly restricted to the lower horizons, has been collected from localities including Burrier, Grassy Gully, Sugar Loaf and Yalwal Creek. More than 60 species were recorded by Laseron (1910) from these localities and his collection is now in the Australian Museum.

Following recent field-work on the South Coast with Mr. L. R. Hall, of the Geological Survey of New South Wales, it is suggested that the Wandrawandian Siltstone may extend south to Berrara where on the coast it is represented by highly fossiliferous mudstones and sandstones.

The underlying Conjola Beds are mainly conglomeratic and pass upwards into coarse pebbly sandstones. They are exposed mainly around Conjola and, it is thought, do not extend any great distance to the south. Harper (1915 : 231) records exposures of these beds underlying the Wandrawandian Siltstone in the Yalwal and Ettrema Gorges.

During recent field-work an exposure of the Conjola Beds was found on the road into Red Head on Portion 180, Parish Conjola, County St. Vincent. The outcrop consists of about 120 ft of a coarse pebbly sandstone and is approximately 500 ft above sea-level. The headlands at Red Head were also found to consist of a Permian basalt and the " Upper Marine " sediments mapped by Harper (1915) are not present. He recorded " Dyke No. 5 " on the north side of the point at sea-level, the intrusion being referred to as bluish-black basalt.

The fossils found in the coarse sandstone at Portion 180 are not particularly well preserved and, in most instances, are in the form of steinkerns. The dominant genera are *Myonia, Edmondia, Stutchburia, Chaenomya, Warthia* and an abundance of *Astartila.* Harper (1915 : 236) recorded a list of somewhat similar genera from near Conjola, together with specimens of *Cleobis grandis* up to 8 in in length.

The Ulladulla Mudstone

This formation consists of the basal beds of the " Upper Marine Series " on the South Coast and extends from South Durras to north of Ulladulla, a distance of approximately 40 miles. The beds consist for the most part of tuffaceous mudstones, sandstones, conglomerates and shales, Numerous glendonites are present in the beds at Ulladulla, together with glacial erratics of considerable size. The beds are rich in fossils throughout the greater part of their vertical extent.

The Ulladulla Mudstone is not well known and there is still much uncertainty regarding it thickness, and junction with the overlying Conjola " Beds ". Harper (1915 : 231) only identified the beds between Kioloa and Ulladulla and he stated that at the latter locality they have a thickness of 100 ft. David (1950 : 347) suggests that the Ulladulla Mudstone continues north beyond Jervis Bay before disappearing beneath younger strata. In the opinion, however, of Mr. L. R. Hall and myself, the field evidence indicates that the Ulladulla Mudstone passes beneath the Conjola " Beds " a few miles north of Ulladulla. It is also considered that the fossiliferous sediments outcropping along the coast north of Red Head are members of the Wandrawandian Siltstone.

Recent field-work, carried out over the extent of the Ulladulla Mudstone as it outcrops on the coast, has indicated that the thickness of the beds has been under-estimated. Harper (1915 : 231) suggested that a gradual thickening of the sediments is constant in a northerly and easterly direction, the general dip being half a degree to the north-west. He also referred to the characteristic rolling of the strata and the formation of very localised anticlines and synclines.

A brief description of the beds, in ascending order, follows :—

South Durras—Ulladulla Mudstone rests with strong unconformity on probable Ordovician rocks—

	ft.
Basal strong conglomerate	12
Slate breccia	6
Sandstone and conglomerate	20
Slate breccia	12
Sandstones and shales	10

(Strike 320°—350°. Dip 6—14° N.E.)

Wasp Point—Mudstones appearing above sandstones with *Eurydesma*, etc.
(Strike 325°—350°. Dip 8—13° N.E.)

Point Upright—Mudstones overlain by sandstone with abundant *Eurydesma*, 60 ft.
(Strike 340°. Dip 3° E.)

Pebbly Beach—Mainly mudstones with traces of fossil casts.
(Strike and dip similar to Point Upright).

O'Hara Head (South)—Mudstones, sandstones and conglomerate. *Edmondia* zone in mudstone. *Stutchburia* and *Chaenomya* present.

O'Hara Head (1 m N. of O'Hara Head South)—Sandstone and mudstones with *Chaenomya*.
(Strike 355°. Dip 10° E.)

Willinga Point—Sandstone and conglomerate; grits and sandy shales; breccia. *Chaenomya* zone.

Crampton Island—Sandstones and mudstones. Fossils rare.

Lagoon Head—Sandstones and mudstones. Abundant fossils.
(Dip north of east—not measured.)

Warden's Head—Mudstones with abundant fossils.
(Strike 350°. Dip 6° W. On southern end of headland reversal of dip by virtue of small flat anticline.)

It would appear from the limited investigations carried out between South Durras and Ulladulla that an estimated thickness of at least 1,000 ft for the Ulladulla Mudstone is more correct than the low figure suggested previously. There are at least 100 ft of sediments from the base of the Ulladulla Mudstone to the Eurydesma Zone at Point Upright and to the north these beds disappear below overlying strata. An interesting feature in this formation is the number of narrow zones which are characterised by numerous shells of various genera. The most important is the Eurydesma Zone mentioned later in this paper.

CONCLUSIONS

A study of the Permian gastropods of New South Wales has proved several important points. It must be recognised first of all that gastropods are easily influenced by changes of physical conditions within certain areas. They are susceptible to environment and because of this are developed to a great extent in comparatively narrow limits within a sequence.

Conditions during the accumulation of the conglomerates and agglomerates found at the base of the Allandale Formation at Harper's Hill, were eminently favourable to the growth of the gastropod fauna. Outstanding are the large and thick-shelled forms found in association with the great accumulations of *Eurydesma*. Their subsequent and sudden burial under a great thickness of contemporaneous volcanic ash resulted in fossil material so beautifully preserved that even the finest ornamentation is revealed.

A second and younger development of gastropods occurred in the topmost beds of the Gerringong Volcanics (Upper Marine Series) at Wollongong, Jamberoo, Gerringong and other localities. A similar fauna is recognised at the base of the Capertee Group at Rylstone (Western Coalfield), and at Bundanoon in the Central Highlands, and a correlation of these three horizons is suggested.

Apart from these two well marked zones the distribution of gastropods in the Permian sequence is sporadic. Considerable thicknesses of sediment are almost devoid of them and when they are found they are generally in the form of steinkerns and rarely well preserved. Another feature is that the gastropods in the two well-defined zones are mainly large shells whereas there is a noticeable diminution in the size of the shells in the remaining horizons.

Gastropod species are restricted in their vertical range and to a large extent in their horizontal distribution and they have not materially assisted in an attempted close correlation of the sub-divisions of the " Upper Marine " rocks of the South Coast and those of the Maitland (Upper Marine) Group of

the type locality in the Hunter River Valley. The sediments of the Shoalhaven Group of the South Coast consist mainly of intermittent sandstones, shales and mudstones, which contain a rich fossil fauna, but the gastropods are largely impoverished and poorly preserved. They show however certain relationships with species from the lower formations of the Branxton Sub-Group in the Hunter River Valley.

On the South Coast at Point Upright, a well marked zone of the pelecypod *Eurydesma* was recently recorded by me (Hill 1955 : 101). The zone is exposed on the cliff-face about 60 ft above the rock-platform and is not met with again to the north where only occasional specimens of *Eurydesma* have been recorded from higher in the sequence. The shells first appear lower in the sequence at Wasp Point about 2 miles to the south where they are fairly abundant but not to the same extent as at Point Upright.

It is considered that this horizon, approximately 100 ft above the base of the Ulladulla Mudstone, should be correlated with the Eurydesma Horizon found in the Hunter Valley at Wattle Ponds Creek, Loder's Dome and at Muswellbrook. These localities are low in the Belford Formation of the Branxton Sub-Group. If this correlation is accepted it means that the Fenestella Shale Formation and the Elderslie Formation, approximately 1,550 ft of sediments, are not represented on the southern margin of the Permian sequence.

On lithological grounds the Berry Shale and the Nowra Sandstone of the Shoalhaven Group have in the past been correlated with the Mulbring and the Muree Formations of the Hunter Valley respectively. It is doubtful, however, whether these formations are represented on the South Coast.

As mentioned earlier in this paper the Gerringong Volcanics, the basal beds of the Capertee Group and the rocks exposed in the Bundanoon Gully, would appear to be contemporaneous on the evidence of the gastropod fauna. A similar fauna is also recognised at Glendon in the Hunter River Valley from species recorded by early authors. There is some doubt regarding the exact geographical position of this locality, but it is almost certain that the sediments are representative of the Belford Formation. The Capertee Group in the Western Coalfield attains a maximum thickness of 650 ft and is generally considered to be the equivalent of the Branxton Sub-Group, in part.

In attempting correlations between the Permian rocks of the South Coast and their equivalents in the Maitland Group of the Hunter River Valley, it is interesting to note the sedimentation revealed by the Kulnura Bore. This bore was put down at Kulnura, west of Gosford, and it proved that the Permian deposits in the middle of the Sydney Basin consist almost entirely of a succession of shales, sandstones and occasional limestones. The facies change is so great that it is impossible to attempt any definite correlations with the known Permian succession to the north or south.

The marine sediments in the Kulnura Bore occur at depths from 3,775 to 4,490 ft, and from 4,667 to 6,279 ft. The Greta Coal Measures are represented by freshwater deposits between the depths at 4,490 to 4,667 ft, while the " Upper Marine " sediments have a thickness of only 715 ft.

It would appear from the available evidence that the complete sequence of Permian marine rocks of the South Coast is the equivalent of the Belford Formation of the Branxton Sub-Group, which in the type locality of the Hunter Valley has a thickness of 1,450 ft. Even when it is realised that the thickness of the Permian rocks of the South Coast is emphasised by the many interbedded volcanic tuffs and lava flows, this conclusion is one which is open to doubt. The suggestion, however, is a tentative one, as it is recognised that a great deal of detailed mapping is still necessary before even the limits and thicknesses of the Permian sub-divisions are known on the South Coast. This work, together with further investigations on the western margin of the Sydney Basin and a more detailed study of the complete fossil fauna, would materially assist in correlations.

NEW NAMES

Cycloscena anomphala gen. et sp. nov.
Keeneia trochiforme sp. nov.
Mourlonopsis strzeleckiana (Morris)
Planikeeneia insculpta gen. et sp. nov.
Planikeeneia minor sp. nov.
Planikeeneia occasa sp. nov.
Platyceras farleyensis sp. nov.
Platyschisma branxtonensis sp. nov.
Pleurocinctosa allandalensis gen. et sp. nov.
Pleurocinctosa elegans sp. nov.
Rhabdocanthus aduncus gen. et sp. nov.
Rhabdocanthus intermedia sp. nov.
Rhabdocanthus irregularis sp. nov.
Strotostoma inflata gen. et sp. nov.
Strotostoma rylstonensis sp. nov.
Walnichollsia pygmaea gen. et sp. nov.
Warthia perspecta sp. nov.

INDEX OF SPECIES

References

Bowsher, A. L. 1955. Origin and adaptation of Platyceratid Gastropods. *Contr. Palaeont. Kans.*, Lawrence. Art. 5

Booker, F. W. 1950. *Rep. Dep. Min. N.S.W.*, Sydney, 1949: 64—66.

————, 1953. Unpublished thesis.

Branson, C. C. 1948. Bibliographic Index of Permian Invertebrates. *Mem. geol. Soc. Amer.*, Washington. 26.

Campbell, K. S. W. 1953. The Faunas of the Permo-Carboniferous Ingelara Beds of Queensland. *Pap. Dep. Geol. Univ. Qd.*, Brisbane.

Carne, J. E. 1908. Geology and Mineral Resources of the Western Coalfield. *Mem. geol. Surv. N.S.W.*, Sydney Geol. 6.

Chronic, John 1949. In Newell, N.D., Chronic, John, and Roberts, T. G. Upper Palaeozoic of Peru. New York. (see also *Mem. geol. Soc. Amer.*, Washington, 1953: 58.

Conrad, T. A. 1842. Descriptions of new species of organic remains belonging to the Silurian, Devonian and Carboniferous systems of the United States. *J. Acad. nat. Sci. Philad.* 8.

Dana, J. D. 1847. Descriptions of fossil shells of the exploring expedition under the command of Charles Wilkes, U.S.N. . . . *Amer. J. Sci.*, New Haven. 54.

————, 1849. *In* United States Exploring Expedition during the years 1838—1842, under the command of Charles Wilkes, U.S.N. 10. Geology.

David, T. W. E. 1950. The Geology of the Commonwealth of Australia. (Arnold: London).

David, T. W. E. and Sussmilch, C. A. 1921. Upper Palaeozoic Glaciations of Australia. *Bull. geol. Soc. Amer.*, Rochester. N.Y. 42.

Dun, W. S. 1913. Marine Fossils from the Tasmanite Spore Beds of the Mersey River. *Tas. Dept. Mines, Geol. Rec.* 1.

Etheridge, jnr., R., 1878. A Catalogue of Australian Fossils. (Cambridge University Press).

————, 1880. Report on a collection of fossils from the Bowen River Coalfield and the limestone of the Fanning River, Northern Queensland. *Proc. R. phys. Soc. Edinb.* 5.

————, 1889. Remarks on fossils of Permo-Carboniferous age from North-West Australia, in the Macleay Museum. *Proc. Linn. Soc. N.S.W.*, Sydney.

————, 1892. See Jack and Etheridge.

————, 1894. Palaeontologia Novae Cambriae Meridionalis: Occasional descriptions of New South Wales Fossils. *Rec. geol. Surv. N.S.W.*, Sydney. 4.

————, 1896. *Ibid.* 5. (1).

————, 1898. *Ibid*, 5, (4).

————, 1902. A New Permo-Carboniferous genus (*Keeneia*) of the Pleurotomaridae, and a *Straparollus* in New South Wales. *Rec. Aust. Mus.* Sydney, 4.

REFERENCES—*continued.*

————————, 1918. Pelecypoda from the Permo-Carboniferous of Bundanoon. *Rec. Aust. Mus.*, Sydney, 11.

————————, 1919. Occasional Descriptions of New South Wales Fossils. *Rec. Aust. Mus.*, Sydney, 12.

Fletcher, H. O. 1943. The Genus *Conocardium* from Palaeozoic Rocks. *Rec. Aust. Mus.*, Sydney, 21.

————————, 1955: Symposium on Contributions to the Correlation and Fauna of the Permian of Australia and New Zealand. (Reviewed by D. Hill). *J. Geol. Soc. Aust.* 2.

Foord, A. H. and Crick, G. C. 1897. Catalogue of the Fossil Cephalopoda in the British Museum (Nat. Hist.) 23.

Frech, F. 1896. Review of R. Etheridge, Jnr., Palaeontologia Novae Cambriae Meridionalis Rec. Geol. Sur. N.S.W. 1894, 4. *Neues Jb. Miner., Mh.*

Girty, G. H. 1908. The Guadalupian Fauna. *Prof. Pap. U.S. geol. Surv.*, Washington, 58.

Grabau, A. W. 1931. The Permian of Mongolia. *Nat. Hist., N.Y.* 4.

————————, 1936. Early Permian Fossils of China ii. *Mem. geol. Surv. China, Pekin.* Ser. B, 8.

Grange, M. J. 1854. In Dumont d'Urville's *Voyage au Pôle Sud.* Geol. 2.

Hall, J. 1859. Natural History of New York. *Geol. Sur.* New York, 3.

Haniel, C. 1915. Die Cephalopoden der Dyas von Timor. *Pal. v. Timor* 3.

Hanlon, F. N. 1948. Geology of the North-Western Coalfield, Pt. 1. *J. roy. Soc. N.S.W.*, Sydney. 81 (1947).

————————, 1948. Geology of the North-Western Coalfield, Pt. 2. *J. roy. Soc. N.S.W.*, Sydney. 81 (1947).

————————, 1948. Geology of the North-Western Coalfield, Pt. 3. *J. roy. Soc. N.S.W.*, Sydney. 81 (1947).

————————, 1949. Geology of the North-Western Coalfield, Pt. 4. *J. roy. Soc. N.S.W.*, Sydney. 82 (1948).

————————, 1949. Geology of the North-Western Coalfield, Pt. 5. *J. roy. Soc. N.S.W.*, Sydney. 82 (1948).

————————, 1949. Geology of the North-Western Coalfield, Pt. 6. *J. roy. Soc. N.S.W.*, Sydney. 82 (1948).

————————, 1950. Geology of the North-Western Coalfield, Pt. 7. *J. roy. Soc. N.S.W.*, Sydney. 82 (1949).

————————, 1950a. Geology of the North-Western Coalfield, Pt. 8. *J. roy. Soc. N.S.W.*, Sydney. 82 (1949).

Harper, L. F. 1905. The Geology of the Gerringong District. *Rec. geol. Surv. N.S.W.*, Sydney. 8.

————————, 1915. Geology and Mineral Resources of the Southern Coalfield. *Mem. Geol. Sur. N.S.W. Geol.* 7.

Haug, E. 1898. Etudes sur les Goniatites. *Mem. Soc. Geol. France.* 7.

Hill, D. 1955. Contributions to the correlation and fauna of the Permian in Australia and New Zealand (Symposium reviewed). *J. Geol. Soc. Aust.* 2.

Jack, R. L. and Etheridge, R. 1892. Geology and Palaeontology of Queensland and New Guinea. (Brisbane and London.)

Jaquet, J. B., Card. G. W., and Harper, L. F. 1905. The Geology of the Permo-Carboniferous rocks in the south-eastern portion of New South Wales. *Rec. geol. Surv. N.S.W.*, Sydney. 8.

Johnston, R. M. 1888. Systematic Account of the Geology of Tasmania. (Hobart).

Joplin, G. A., Hanlon, F. N., and Noakes, L. C. 1953. Explanatory Notes to the Wollongong—4 mile Geol. Ser. (Bureau of Mineral Resources, Canberra).

Jukes, J. B. 1847. Notes on the Palaeozoic Formations of New South Wales and Van Diemen's Land. *Quart. J. geol. Soc. Lond.* 3.

Keyes, C. R. 1890. Synopsis of American Carbonic Calyptraeidae. *Proc. Acad. nat. Sci. Philad.*

Knight, J. Brookes 1934. The Gastropods of the St. Louis, Missouri, Pennsylvanian Outlier: 7. The Euomphalidae and the Platyceratidae. *J. Paleont.*, Tulsa. Okla. 8.

————————, 1936. Notes of Palaeozoic Gastropods. *J. Paleont.*, Tulsa, Okla. 10.

————————, 1941. Palaeozoic Gastropod Genotypes. *Spec. Pap. geol. Soc. Amer.*, Washington. 32.

Koninck, L. G. de. 1877. Recherches sur les Fossiles Palaéozoïques de la Nouvelles-Galles du Sud (Australie). *Soc. des Sci. Nat. Liège. Mem. Ser.* 2, 6—7. (Translation in *Mem. geol. Surv. N.S.W.*, Sydney, 1898. Pal. 6.

Laseron, C. F. 1910. Palaeontology of the Lower Shoalhaven River. *J. roy. Soc. N.S.W.*, Sydney. 44.

M'Coy, F. 1847. On the Fossil Botany and Zoology associated with the coal in Australia. *Ann. Mag. nat. Hist.* London 20.

McElroy, C. 1953. Unpublished thesis.

Meek, F. B. and Worthen, A. H. 1868. Palaeontology. *Geol. Sur. Illinois.* 3.

Mitchell, J. 1922. A New Gastropod (Fam. Euomphalidae) from the Lower Marine of New South Wales. *Proc. Linn. Soc. N.S.W.* Sydney, 47.

Mitchell, T. L. 1838. *Three Expeditions into Eastern Australia.* (London).

Morris, J. 1845. Descriptions of Fossils. In Strzelecki, "Physical Description of New South Wales and Van Diemen's Land". (London).

Plews, H. T. 1858. On the Coalfield of New South Wales. *Mining Inst. J.* 6 (3).

Raggatt, H. G. 1938. Unpublished thesis.

————————, 1939. Department of Mines, New South Wales. (Unpublished Misc. Pap. 39/5160).

Raggatt, H. G. and Fletcher, H.O. 1937. A Contribution to the Permian-upper Carbiniferous Problem and an Analysis of the Fauna of the Upper Palaeozoic (Permian) of the North-West Basin, Western Australia. *Rec. Aust. Mus.* 10.

Rayner, E. O. and McElroy, C. T. 1956. Explanatory Notes to the Sydney—4 miles Geol. Ser. (Bureau of Mineral Resources, Canberra).

Reed, F. R. C. 1930. A New Permo-Carboniferous Fauna from Brazil. *Serv. Geol. Min. Brazil.* Mon. 10.

————————, 1932. New Fossils from the Agglomeratic Slate of Kashmir. *Palaeont. indica.* N.S. 20: 1.

Reid. J. H. 1929. Geology of the Bowen River Coalfield. *Qd. Geol. Sur. Pub.* 276.

Schuchert, C. 1928. Review of the late Palaeozoic Formations and Faunas with special reference to the ice-age of Middle Permian times. *Bull. Geol. Soc. Amer.* 39.

Sowerby, C. 1838. Fossils. In Mitchell, T. L., *Three Expeditions into the Interior of Eastern Australia* " (London).

REFERENCES—*continued.*

Strzelecki, P. G. de. 1845. *Physcial Description of New South Wales and Van Diemen's Land.* (London).

Teichert, C. 1953. A New Ammonoid from the Eastern Australian Permian Province. *J. roy. Soc. N.S.W.* 87.

Teichert, C. and Fletcher, H. O. 1943. A Permian Ammonoid from New South Wales and a Correlation of the Upper Marine Series. *Rec. Aust. Mus.*, 21.

Thomas, H. D. 1929. The late Palaeozoic Glaciation. *Nature.* 123.

Voisey, A. H. 1936. The Upper Palaeozoic Rocks around Yessaban, near Kempsey, New South Wales. *J. roy. Soc N.S.W.*, Sydney, 70.

————————, 1936a. The Upper Palaeozoic Rocks in the Neighbourhood of Boorook and Drake, New South Wales. *Proc. Linn. Soc. N.S.W.* Sydney, 61.

————————, 1939. The Geology of the Lower Manning District of New South Wales. *Proc. Linn. Soc. N.S.W.* Sydney, 64.

————————, 1950. The Permian Deposits of Jeogla and Kangaroo Creek, N.S.W. New England University College *Sci. J.*

————————, 1951. The Permian Rocks of the Manning-Macleay Province, N.S.W. *J. roy. Soc. N.S.W.* Sydney, 84.

Waagen, W. 1880. Salt Range Fossils. Pt. 2. *Palaeont. indica* Ser. 13, 1.

————————, 1891. Salt Range Fossils. *Palaeont. indica. Ser.* 13, 4.

Walkom, A. B. 1913. Stratigraphical Geology of the Permo-Carboniferous System in the Maitland-Branxton District *Proc. Linn. Soc. N.S.W.* Sydney, 33.

Wanner, J. 1922. Die Gastropoden und Lamellibranchiaten der Dyas von Timor. Pal. von Timor, 11 (xviii).

Whitehouse, F. W. 1926. Notes on the Upper Palaeozoic Marine Horizons in Eastern and Western Australia. *Rep. Aust. N.Z. Ass. Adv. Sci.* Sydney, 18.

EXPLANATIONS OF PLATES

Unless otherwise stated Figures are approximately natural size.

Photography, unless otherwise stated, is by Mr. Howard Hughes, Australian Museum.

Plate 7

Rhabdocanthus altum (Etheridge)
1. Neotype, F.35587. Side view showing curvature, straight apertural margin and growth undulations. Figured Etheridge (1896 : pl. i, figure 1).
2. The neotype. Front view showing twisted apex.
3. A smaller specimen, F.35585, figured Etheridge (1896 : pl. i, figure 2).
4. Front view of figure 3.

Rhabdocanthus cornucapella (Etheridge)
5. Holotype, F.35588, showing transverse ridges and curvature. Figured Etheridge (1896 : pl. 1, figure 3).
6. Holotype; another side view showing transverse ridges, longitudinal and transverse lirae.
7. Front view of the holotype, showing slightly twisted apex; the point is missing.

Rhabdocanthus aduncа sp. nov.
8. Holotype, F.46400. Side view showing strongly incurved apex and ornamentation.
9. A front view of the holotype, showing lateral compression.

Rhabdocanthus intermedia sp. nov.
10. Holotype, F.26950. Side view showing curvature transverse ridges and ornamentation.
11. Front view of the holotype.

Rhabdocanthus ungula (Etheridge)
12. A plesiotype, F.46402. Side view showing almost straight ventral margin.

Plate 8

Rhabdocanthus ungula (Etheridge)
1. Holotype, F.35586. Side view showing conical form. Figured Etheridge (1896 : pl. 1, figure 4).
2. Front view of holotype.
3. Apical view of holotype.

Rhabdocanthus irregularis sp. nov.
4. The paratype, F.30131 ; side view.
5. Apical view of the paratype, showing expansion of shell and asymmetrical form.

Platyceras farleyensis sp. nov.
6. Holotype, F.30004. Side view showing coiled apex in contact with body whorl.

Strotostoma rylstonensis sp. nov.
7. A paratype, F.45392. Apical view showing reduced spire and enlarged body whorl.
8. An impression of the ornamentation from F.39625.
9. The holotype, F.40940. A side view of the body whorl showing ornamentation and basal extension.
10. Apical view of the holotype.
11. Paratype, F.39682, showing false umbilicus and obliquely distended aperture.

Plate 9

Rhabdocanthus irregularis gen. et sp. nov.
1. Holotype, F.27525. Side view showing growth undulations and general form.
2. Front view of holotype showing pointed and twisted apex.

Rhabdocanthus ungula (Etheridge)
3. A topotype, F.30146, showing conical form.
4. Front view of the same specimen.

Strotostoma rylstonensis gen. et sp. nov.
5. A small specimen, F.6430, from Gerringong. Characteristic ornamentation shown on small portion of penultimate whorl.

EXPLANATIONS OF PLATES—*continued.*

Plate 9—continued.

Strotostoma inflata gen. et sp. nov.
6. Paratype, F.44246. An oblique apertural view.
7. Holotype, F.45350. An apical view.
8. Side view of holotype showing inflation of body whorl.

Mourlonopsis strzeleckiana (Morris)
9. Apical view of a large specimen, F.21762, from Gerringong.
10. Side view of a steinkern, F.29735, from Wollongong, showing narrow slit-band.
11. Apertural view of a smaller specimen, F.21530, from Gerringong, showing inner and outer lips.

Plate 10

Cycloscena anomphala gen. et sp. nov.
1. Holotype, F.29777. An apical view.
2. Side view of holotype, showing ornamentation, peripheral carina and pointed apex.
3. Basal view of the paratype, F.46586.

Keeneia trochiforme sp. nov.
4. The holotype, F. 46571. An apical view showing slight shoulders and steeply sloping whorl faces.
5. Side view of the holotype showing ornamentation.
6. Basal view of holotype.

Plate 11

Keeneia trochiforme sp. nov.
1. The paratype, F.46572. Apertural view showing portion of ornamentation and steeply sloping whorl faces. Slightly less than natural size.
2. Apical view of paratype. Less than natural size.

Pleurocinctosa trifilata (Dana)
3. Two specimens, F.21535, from Gerringong. Note the third indistinct carina below the periphery of the body whorl. Enlarged.
4. A slightly oblique apertural view, showing moderately inflated lower half of body whorl. Enlarged.
5. An apertural view of a specimen, F.21395, from Gerringong. Well preserved columella lip. Enlarged.
6. Slab, F.21251, from Gerringong, showing usual mode of occurrence. Enlarged.

Pleurocinctosa allandalensis gen. et sp. nov.
7. Topotype, F.27545, showing selenizone on unweathered portion of whorls. Enlarged.
8. Steinkern showing rounded whorls. Enlarged.
9. Slightly oblique apertural view of a topotype.

Plate 12

Pleurocinctosa elegans gen. et sp. nov.
1. Slab containing the holotype, F.46587, showing well differentiated whorls and tricarination. Enlarged.

Pleurocinctosa allandalensis gen. et sp. nov.
2. A greatly enlarged apertural view of a topotype, F.27524, showing minute umbilicus and almost complete aperture.
3. Slab from a narrow zone in the Allandale Formation at Harper's Hill; mainly steinkerns and impressions.

Walnichollsia pygmaea gen. et sp. nov.
4. The holotype, F.46585. Apical view showing partly weathered ornamentation.
5. Basal view of holotype, showing spiral costae and wide umbilicus.
6. Apertural view of the holotype, showing very depressed spire.
7. Steinkern, paratype F.21634, from Wyro, near Ulladulla. A portion of shell on the apex shows characteristic ornamentation.
8. Impression, F.21256, showing well preserved spiral costae and finer transverse lirae of the ornamentation.

Plate 13

Walnichollsia subcancellata (Morris)
1. Specimen from Rylstone, F.43066, showing weathered ornamentation and selenizone above the periphery of the whorl. An oblique apical view, slightly reduced.
2. Apertural view of F. 43066, showing rounded outer whorl face, selenizone and aperture. Natural size.
3. Flattened specimen, F.28310, from Branxton, showing ornamentation. Slightly reduced.
4. Apical view of a specimen, F.45348, from Rylstone. Natural size.
5. Basal view of F.45348, showing spiral costae and wide umbilicus. Considerably reduced.
6. Side view of F.45348. Extreme apical whorls missing. Considerably reduced.

Plate 14

Keeneia platyschismoides Etheridge.
1. F.7257, (holotype of Knight 1941 : 163). Figured by Etheridge 1902 : pl. xxxii, figure 2. An apertural view; apical whorls absent. Reduced.
2. Apical view of the holotype; note missing apex.

Planikeeneia minor gen. et sp. nov.
3. The holotype, F.46578. Figured by Etheridge 1898 : pl. xix, figures 14—17, as *Platyschisma oculus* (Sowerby). An apical view showing ornamentation. Natural size.
4. Basal view of the holotype. Natural size.
5. Partly decorticated specimen, F. 46589, from the type locality. An apical view.
6. Apertural view of F.46589, showing transversely produced aperture, angulate periphery of the body whorl and depressed spire.

Plate 15

Keeneia platyschismoides Etheridge
1. The syntype, F.7258, figured by Etheridge 1902 : pl. xxxii, figure 1. A side view showing the strongly carinate periphery of the body whorl, sloping whorl faces and well developed shoulder below the upper shoulder. Considerably reduced.
2. Apical view of the syntype, F.7258. Considerably reduced.

EXPLANATIONS OF PLATES—*continued.*

Plate 15—continued.

Warthia perspecta sp. nov.

3. Side view of F.35733, figured by Etheridge 1894 : pl. vii, figure 10, as *Goniatites* (*Prolecanites*?) *micromphalus* (Morris).
4. Anterior view of F.35733, showing inflated whorl and wide shallow sinus.
5. Side view of a specimen, F.39686, from Wollongong.
6. Anterior view of F.39686, slightly oblique, showing sinus.
7. Side view of a larger specimen, F.8215, from Wollongong.
8. Apertural view of F.8215, showing narrow and wide aperture.
9. Plaster cast of holotype figured by Dana 1849 : pl. x, figures 6a, b. A side view.
10. Apertural view of the holotype.

Warthia stricta (Dana)

11. Side view of a specimen, F.1081, from Gerringong showing lateral margin of aperture and trace of the narrow sinus.
12. An anterior view of F.1081, showing lateral compression.
13. Plaster cast of the holotype, figured by Dana 1849 : pl. x, figures 5a, b. A side view.
14. An apertural view of the holotype.

Plate 16

Platyschisma branxtonensis sp. nov.

1. The holotype, F.28297. An apical view showing regular coiling of the spire.
2. Side view of the holotype showing inflection of transverse lirae on the periphery of the body whorl.
3. Oblique apertural view of the holotype showing rounded whorls.

Warthia micromphala (Morris)

4. Side view of a specimen, F.8174, from Wollongong, showing characteristic wide transverse ridges.
5. Side view of another specimen, F.7936, from Wollongong, showing lateral margin of aperture and ridges.

Platyschisma rotundatum (Morris)

6. Oblique apical view of specimen, F.45323, from Rylstone. A steinkern.
7. A more depressed specimen, F.29925, from Branxton. An oblique apical view showing transverse thickenings of the shell.
8. Side view of a steinkern, F.2192, from Wollongong. The extreme apical whorls are missing.
9. An oblique apical view of F.2192.

Plate 17

Planikeeneia depressum (Dana)

1. The holotype, F.27084, of *Platyschisma allendalensis* Mitchell (1922 : pl. xxxv, figures 1—2). An apertural view; considerably reduced.
2. Apical view of F.27084. The specimen is a steinkern and the apex of the spire is missing. Considerably reduced.

Planikeeneia insculpta gen. et sp. nov.

3. The holotype, F.29904. Apical view showing ornamentation. Natural size.
4. Apertural view of the holotype, showing depressed spire and portion of the thickened columellar lip. Natural size.
5. Basal view of holotype. Natural size.

Plate 18

Planikeenia depressum (Dana)

1. Plaster cast, L.694, of the holotype, figured by Dana 1849 : pl. x, figures 2a, b. An apical view showing transversely produced and flattened body whorl. Considerably reduced.
2. Apertural view of L. 694, showing the depressed spire and flattened outer whorl face. Considerably reduced.

Planikeeneia occasa gen. et sp. nov.

3. The holotype, F.28295. An apical view slightly enlarged.
4. Apertural view of holotype, showing thickened columellar and lower lip. Slightly enlarged.
5. The steinkern, F.6601, figured by Etheridge 1919 : pl. xxviii, figure 9 as ?*Platyschisma rotundatum* var. *farleyensis*. Slightly enlarged.
6. Paratype, F.29869. An apical view.

Plate 19

Keeneia ocula (Sowerby)

1. The holotype, B.M.N.H. No. PG. 1061, figured by Sowerby 1838 : pl. ii, figures 3—4 as *Trochus oculus*. Side view showing growth lines and outline of body whorl.
2. The holotype ; apertural view.
3. The holotype. Basal view, showing thickening of the inner lip.
4. A topotype, F.27535. Apertural view showing inner lip and broken outer lip.
5. Apical view of F.27535, showing ornamentation and growth lines.
6. Enlarged portion of the body whorl of F.27535, showing the inflection of the lirae as they cross the whorl periphery.
7. The specimen figured by Morris 1845 : pl. xviii, figure 1. (B.M.N.H. No. 96901). Side view showing growth lines and outline of body whorl.

Figures 1, 2, 3, 7 : *British Museum photographs.*

Plate 20

Keeneia ocula (Sowerby)

1. The specimen figured by Morris 1845 : pl. xviii, figure 1 (B.M.N.H. No. 96901). An apical view.
2. Side view of Morris's specimen. Only the shell of the outer lip is missing.
3. Basal view of B.M.N.H. No. 96901, showing the abraded inner lip.
4. The holotype, B.M.N.H. No. PG. 1061. Apical view showing the extent to which the specimen is weathered.
5. Apical view of a specimen, F.27539, from the type locality.
6. Basal view of F. 27539.

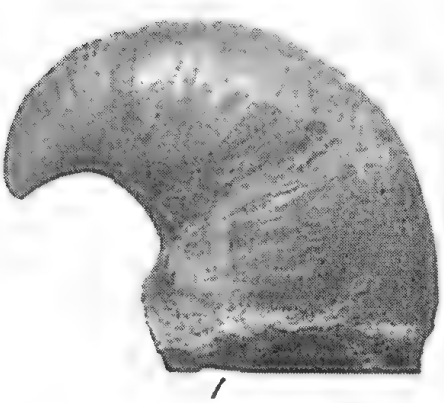
Figures 1 *to* 4 : *British Museum photographs.*

Plate 21

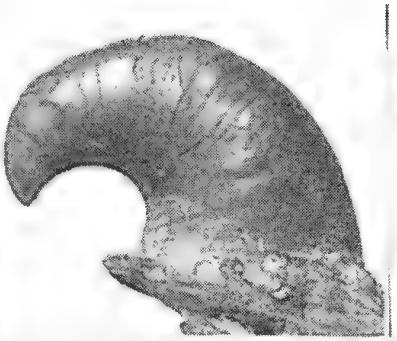
Paromphalus ammonitiformis (Etheridge)

1. Apical view of a plesiotype, F.30018. A steinkern. Natural size.
2. The holotype, F.7669, figured by Etheridge 1902 : pl. xxxiii, figures 1—2. An apical view. Natural size.
3. Apertural view of the holotype, showing rounded outline of the whorl and shape of the aperture. Natural size.
4. A small plesiotype, F.28302, with original shell showing well preserved ornamentation. Natural size.
5. Greatly enlarged portion of F.28302, showing ornamentation.

Sydney: V. C. N. Blight, Acting Government Printer—1958



1

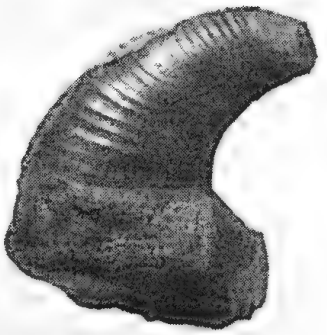


3

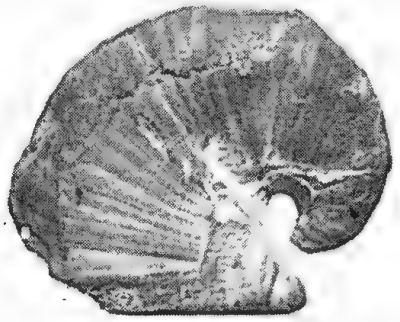
5

2

4

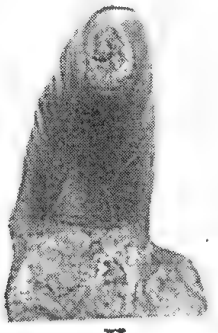


6



8

10

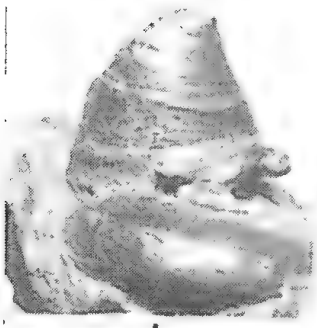


7

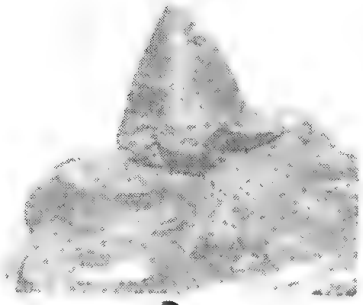
11

9

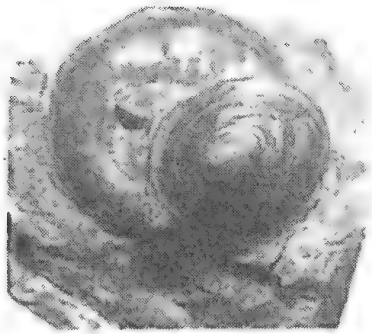
12



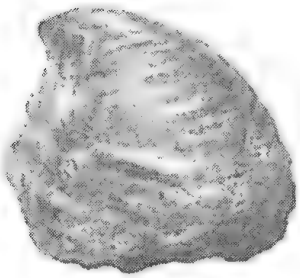
1



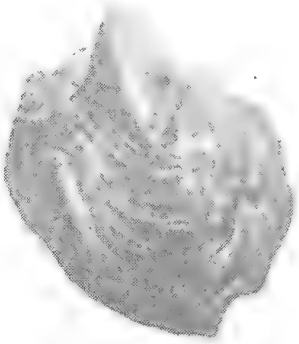
2



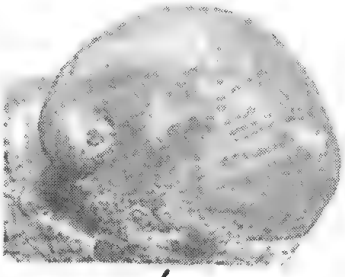
3



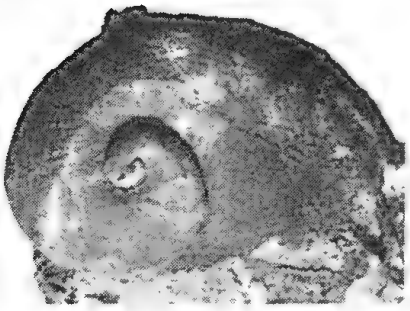
4



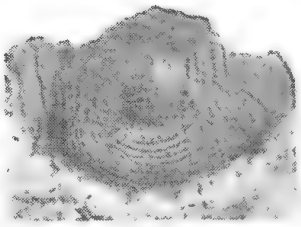
5



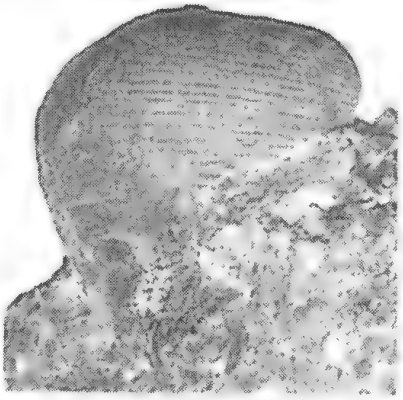
6



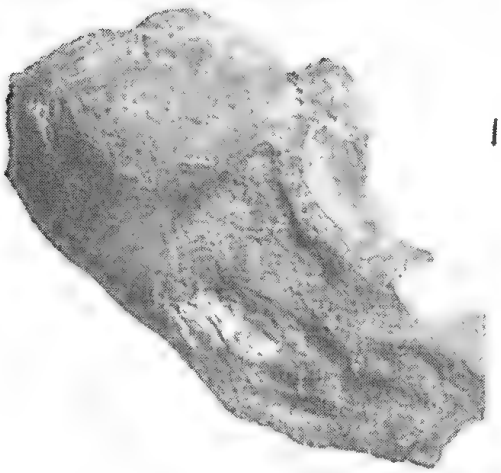
7



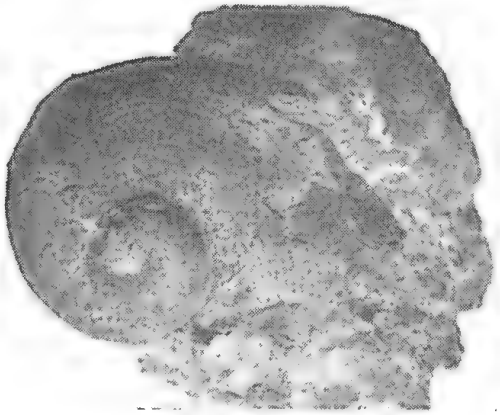
8



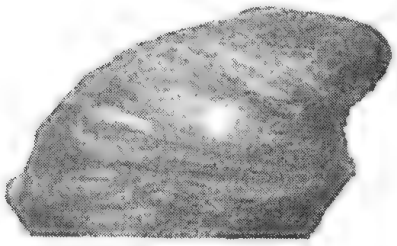
9



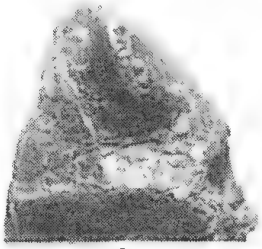
11



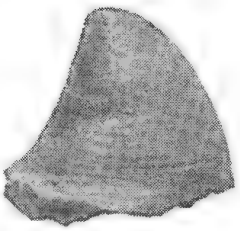
10



1

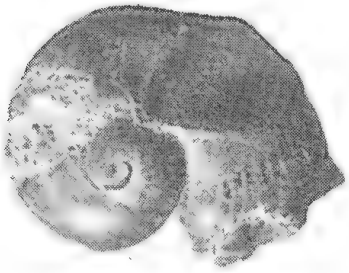


2



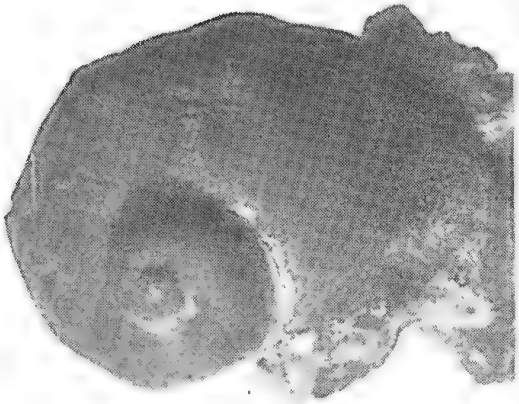
3

4

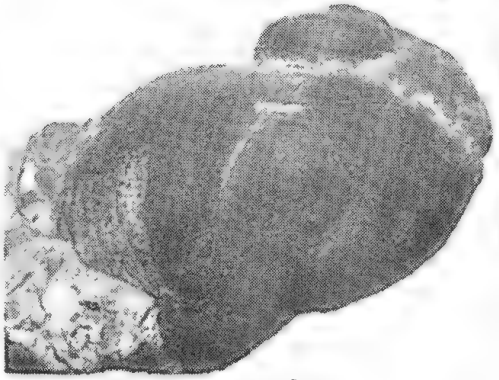


5

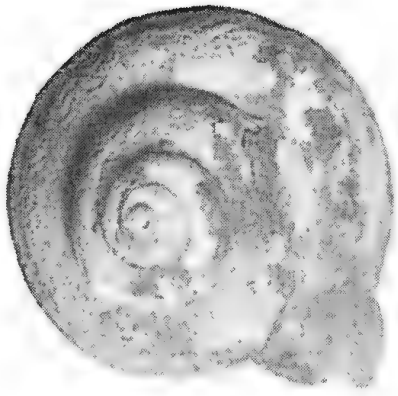
6



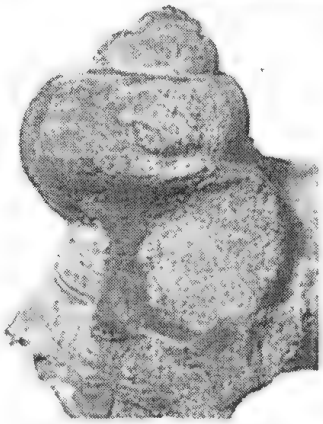
7



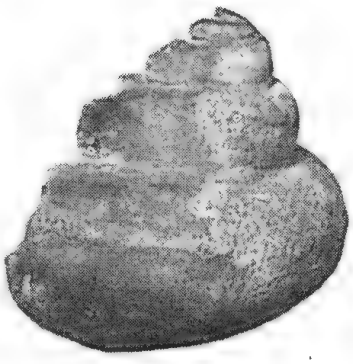
8



9



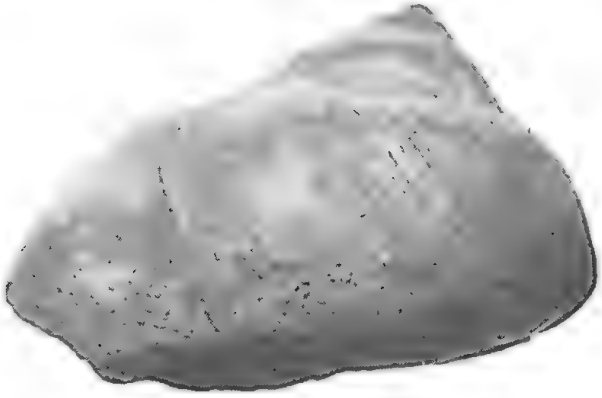
11



10

1

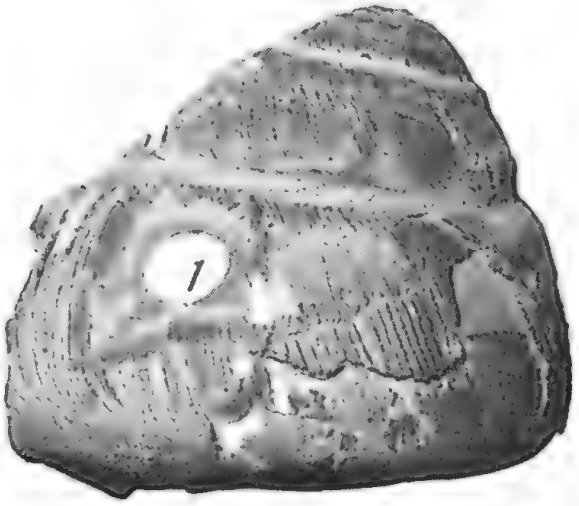
3



2

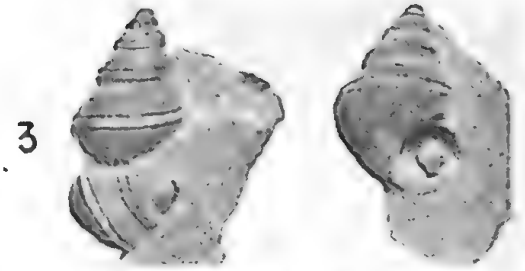
4

6

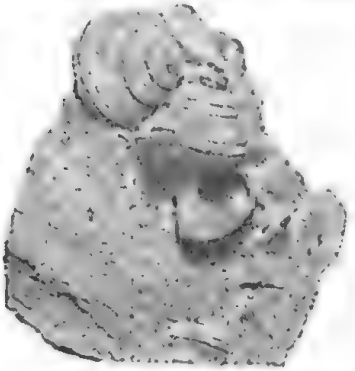


5

1

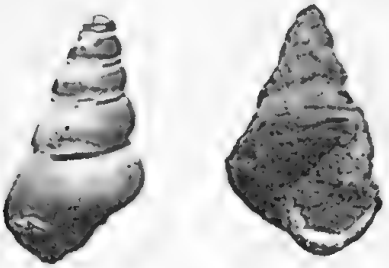


3 4



5

7

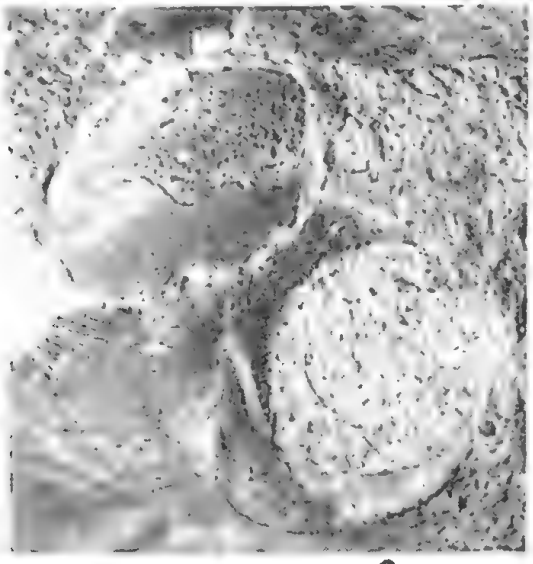


8 9

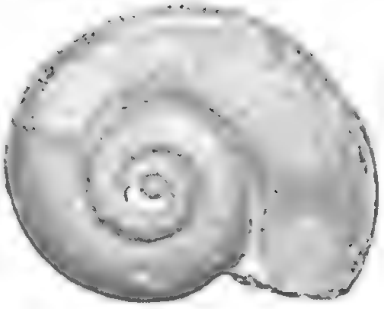
6

2

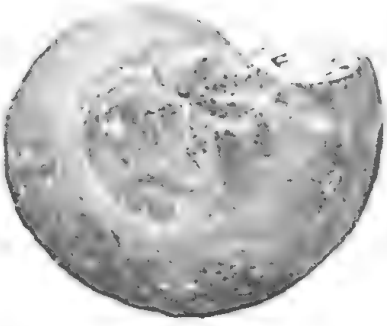
1



2

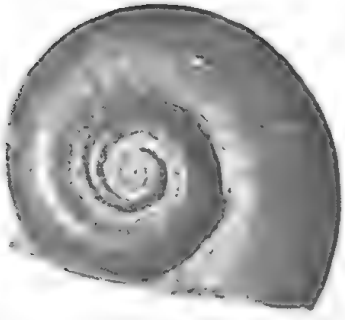


4

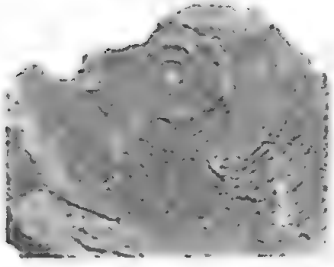


5

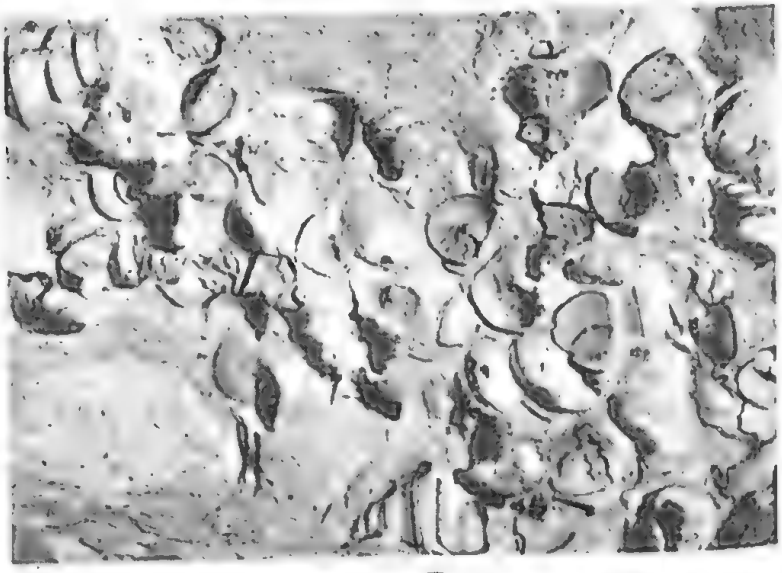
6



7



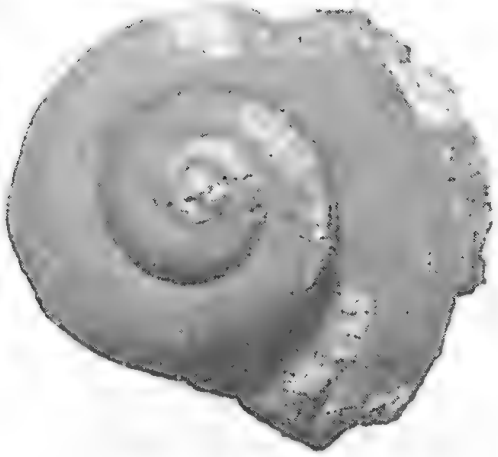
8



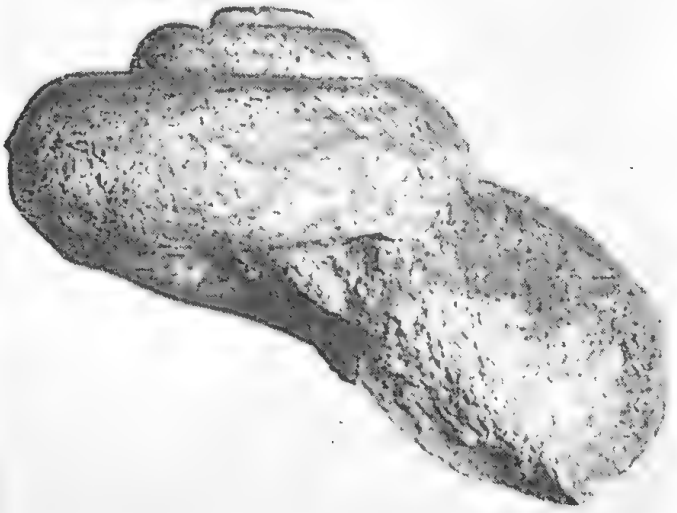
3

1

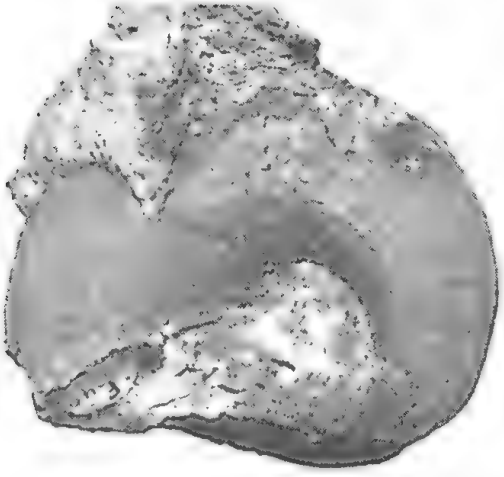
3



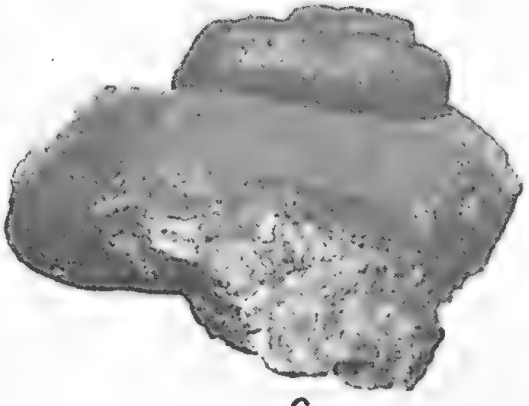
4



2

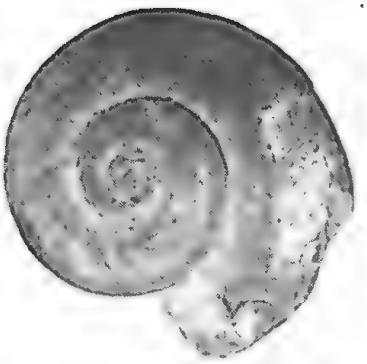


5



6

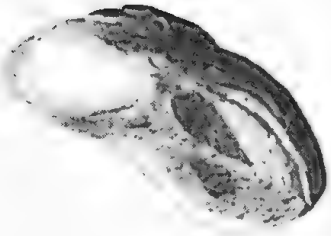
1



3

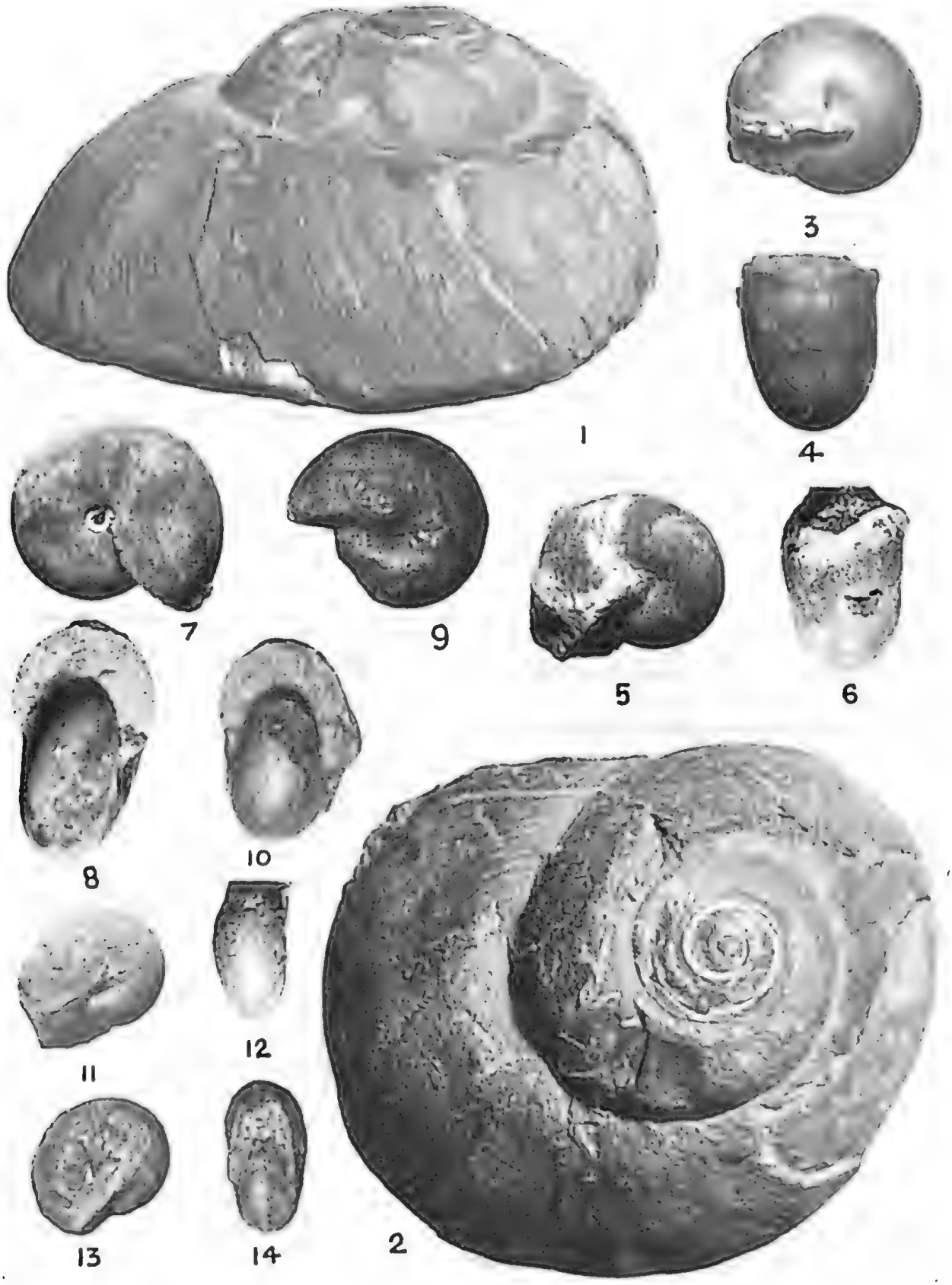
4

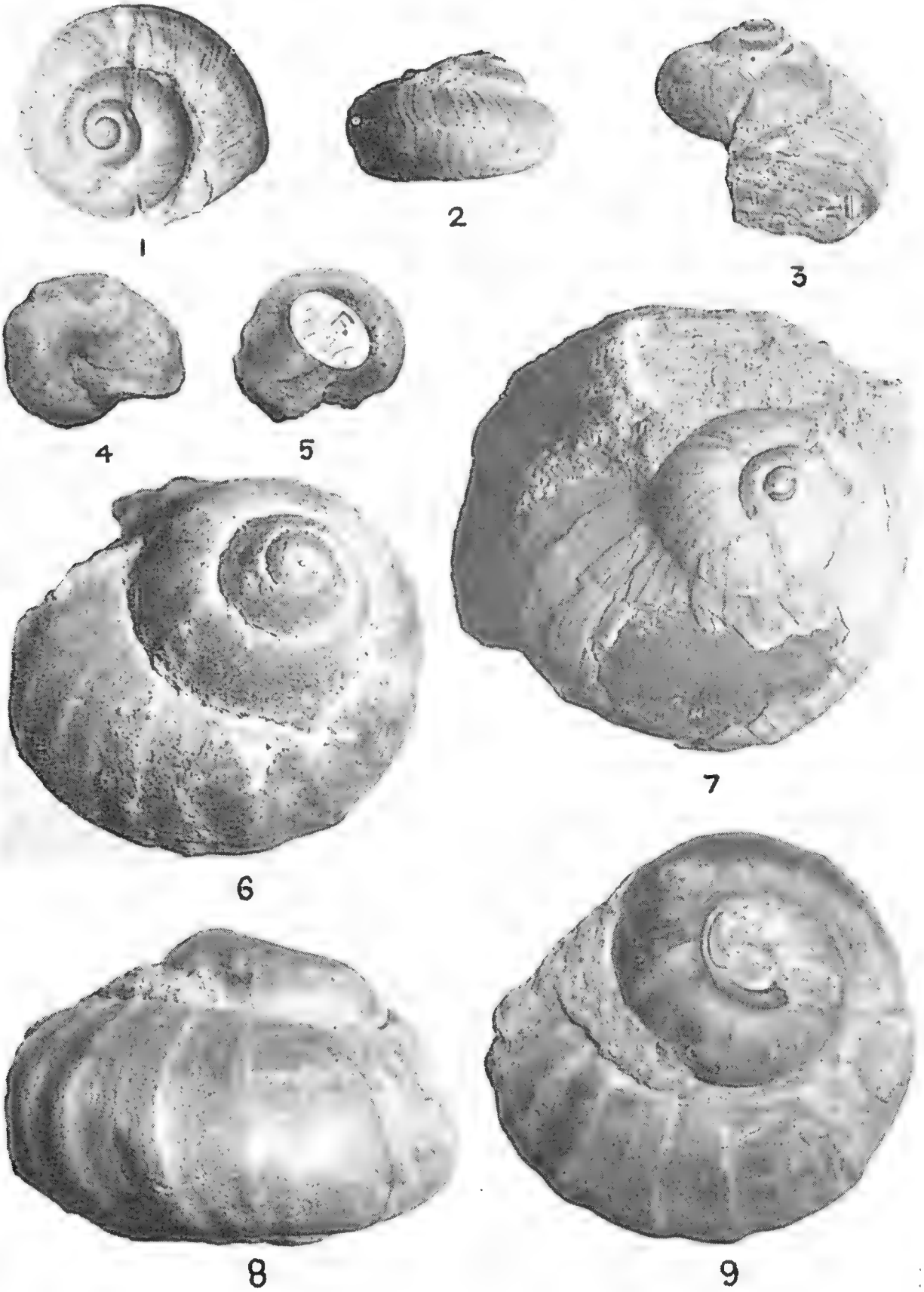
5

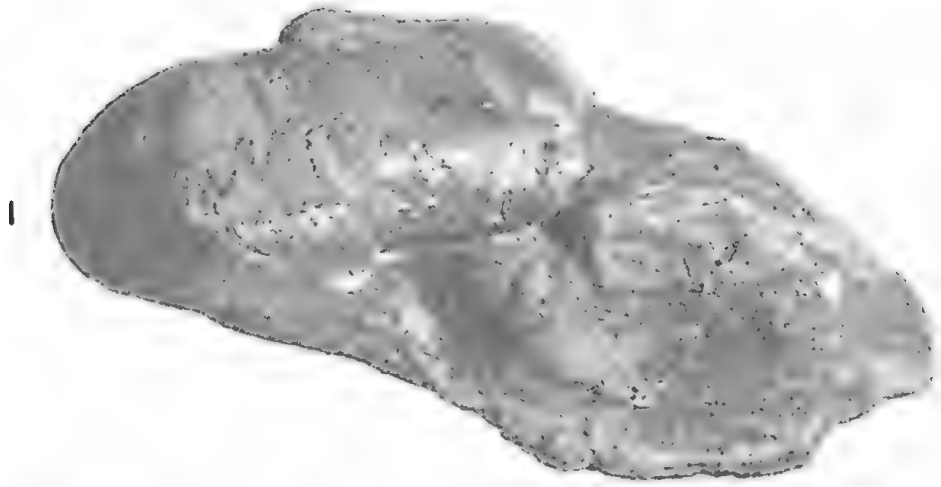


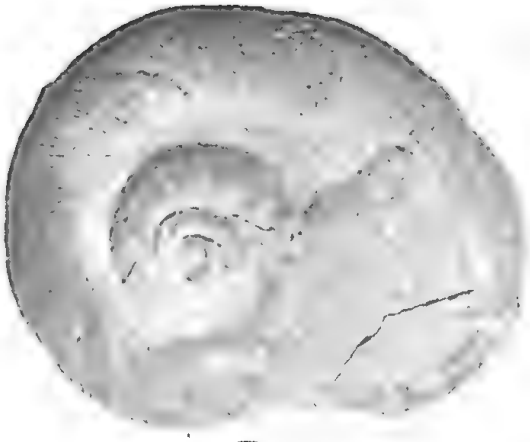
6

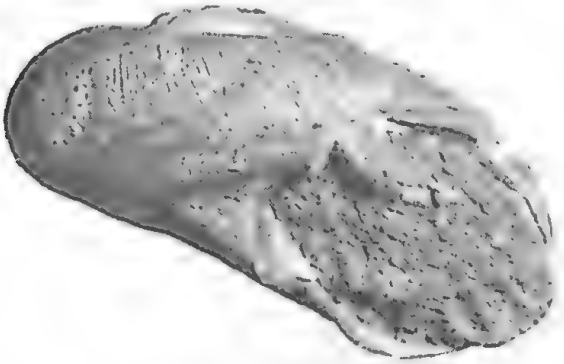
2

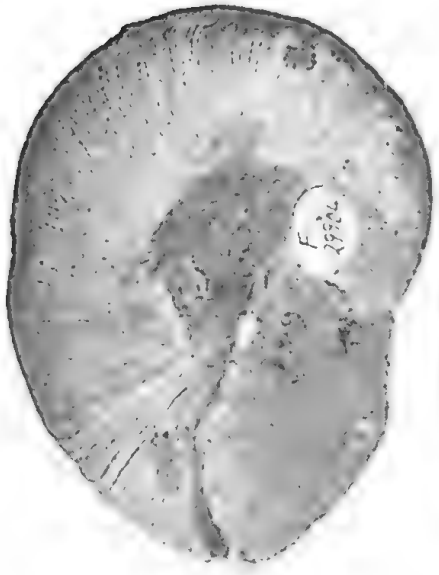

1
2
3
4
5
6
7
8
9
10
11
12
13
14

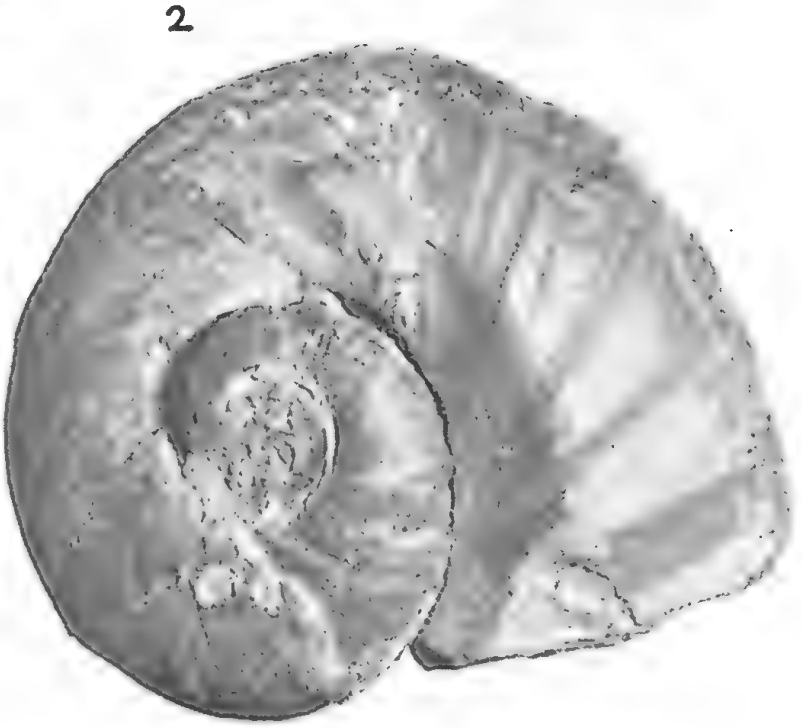

1
2
3
4
5
6
7
8
9

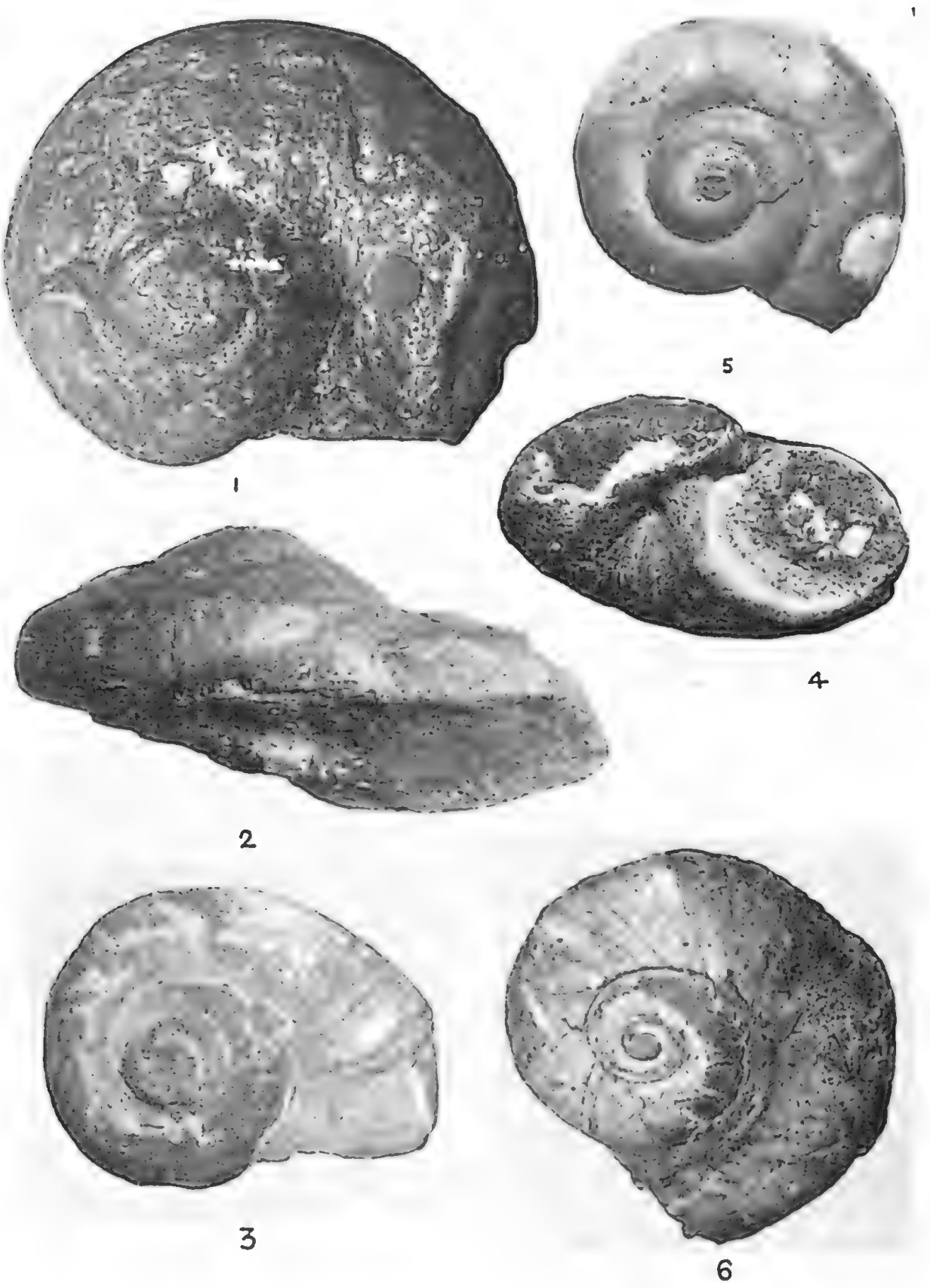

1

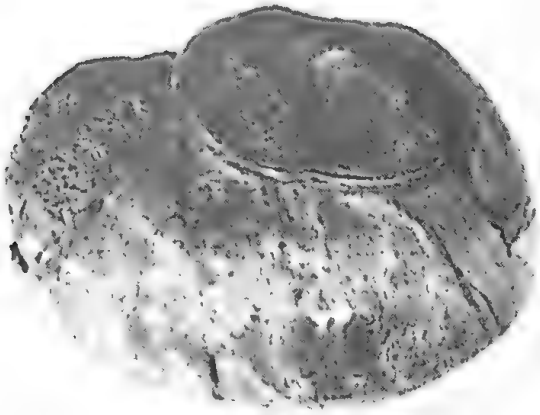

3


4


5

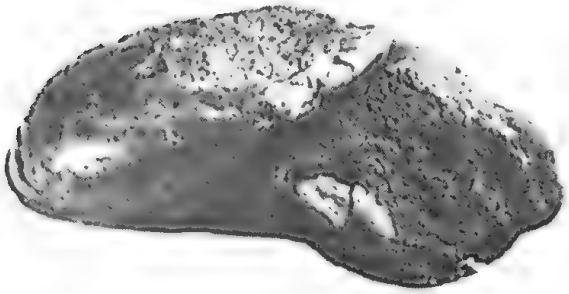

2


1
5
1
4
2
3
6

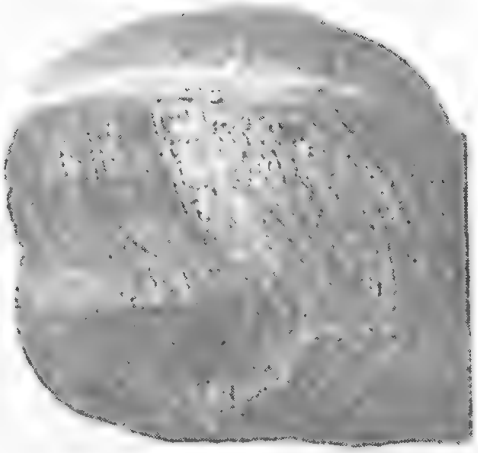


1

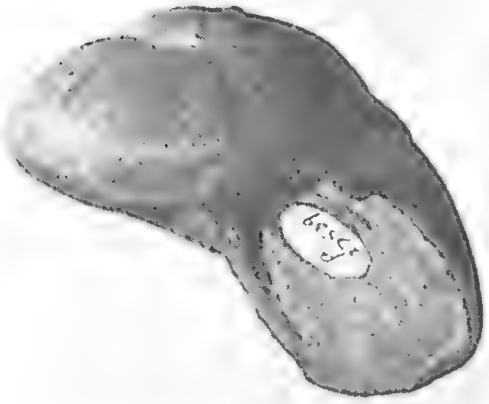
3



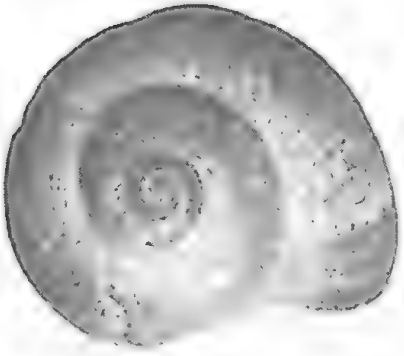
2



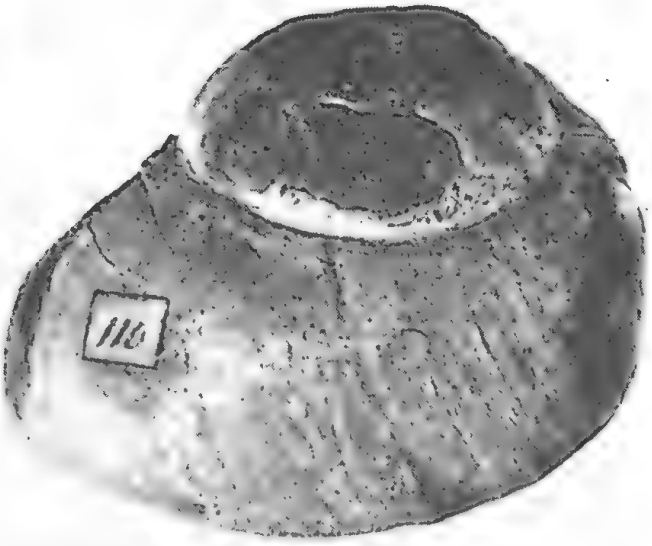
6



4

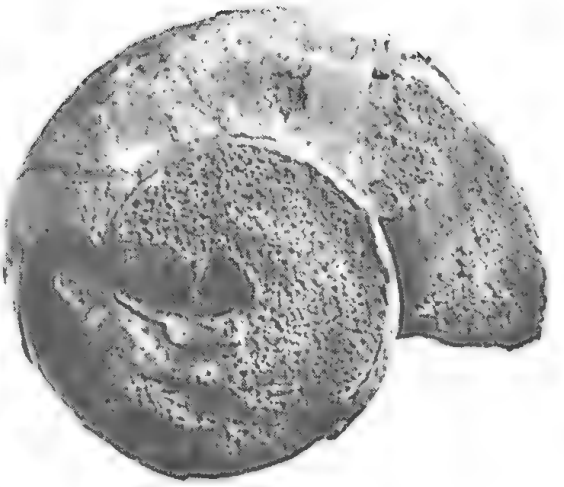


5

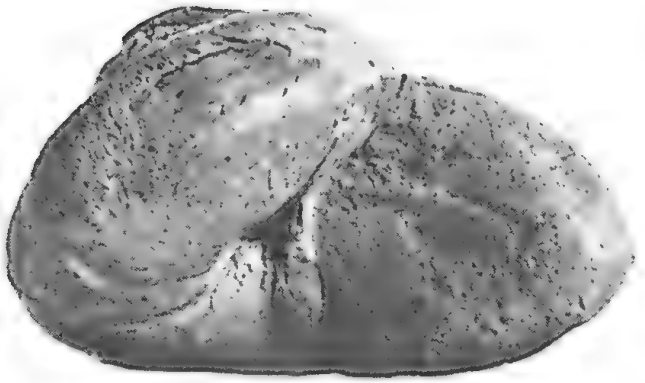


7

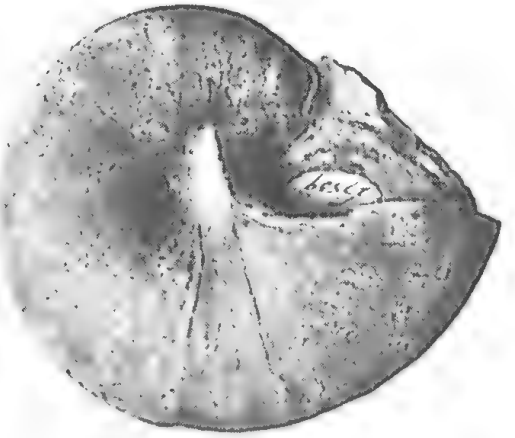
1



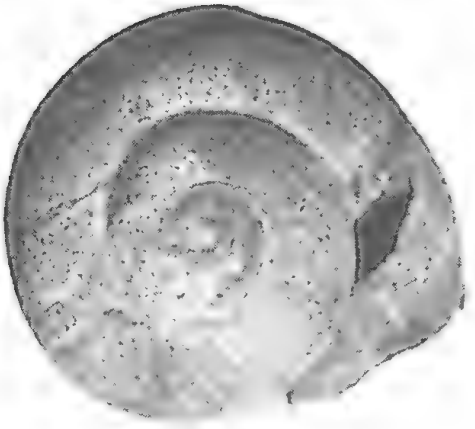
4



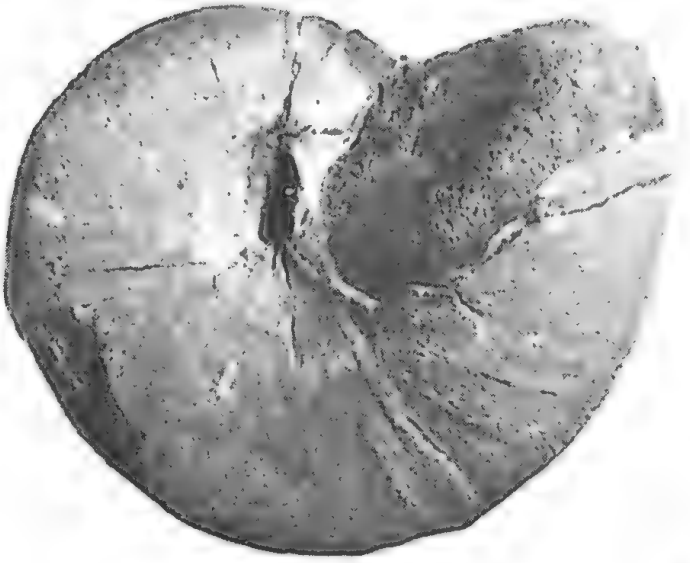
2



6

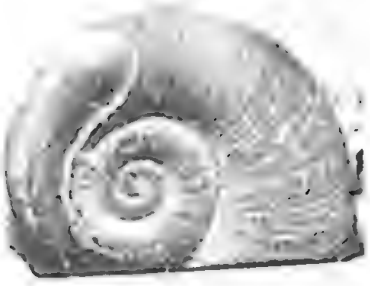


5

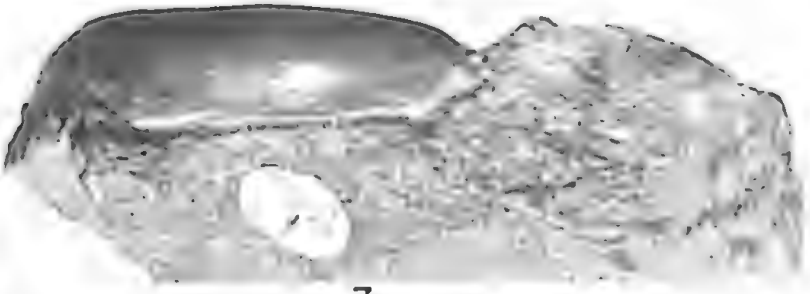


3

1



4



3

5

2

LIOTIIDAE AND ALLIED MOLLUSCS FROM THE DAMPIERIAN ZOOGEOGRAPHICAL PROVINCE*

By Charles F. Laseron

(Figures 1–87)

(Manuscript received 19.9.56.)

INTRODUCTION

This paper is based on two collections from Darwin, Northern Territory, which, as far as is known, are the only collections of small shells available from within the Dampierian Zoogeographical Province. The first collection was made by the author's son, John Laseron, from the beaches at Darwin during the war years, the second from a dredging in 17-20 fm of Pt. Charles, Darwin, by Mr. Mel Ward. As the field is so large it has been thought advisable to deal with these collections family by family rather than as a whole. Material from these collections has already been incorporated in papers dealing with both the Solanderian and Dampierian Provinces on the Cerithiopsidae, the Rissoinidae and Rissoidae, and the Ctiloceratidae (the last in co-authorship with Tom Iredale). The present paper, however, deals only with the Dampierian Province.

No species of Liotiidae has previously been recorded from within the Dampierian Province, but several species have been described from Torres Strait, where there is an overlap with the Solanderian fauna. The presence of some of these species at Darwin is not surprising, and shows them to be essentially Dampierian in range. One species from southern Queensland also occurs at Darwin, also a slightly divergent race of a Peronian species, the latter so far not recorded from any intermediate locality. With these exceptions all the species have been described as new. Generic revision has also been undertaken. All in all 28 forms are here reviewed and figured. Of these 7 have been previously described, 6 from Torres Strait and 1 from the southern Queensland coast. New species number 20 and in addition there is a new subspecies of a Peronian species. All have been divided into 17 genera of which 11 are proposed as new. None of these includes *Liotia* proper, which, however, is found on the Queensland coast, and will also probably be found in north Australia.

CLASSIFICATION

The limitations of Liotiidae as a family are not yet known. The genus *Liotia* Gray on which it is based is a heavy turbinate shell, relatively large, with strong cancellate sculpture, umbilicate, the aperture round and entire and surrounded by a heavy varix. The operculum, which separates it from the Turbinidae, is horny, with an external calcareous coat formed of separate, pearl-like, shelly particles spirally arranged. As the animals and opercula of very few species are known there is no data by which to arrive at the true classification of the majority of shells which at one time or another have been assigned to the family. It is probable that several distinct families are present, some of which may have little relationship with each other. For these reasons the term Liotiidae is here used in the widest sense, and is by no means considered to be the ultimate classification.

Earlier authors have adopted varying classifications. H. & A. Adams (1858) used Liotinae as a subfamily of the Trochiidae to contain such genera as *Liotia* and *Cyclostrema*, Umboniinae as another subfamily to include *Isanda*, *Chrysotoma* and others, while A. Adams' own genus *Teinostoma* was placed near *Neritula* in the Nassinae. Fischer (1887 : 833) proposed a new family Cyclostrematiidae as distinct from Liotiidae to include *Cyclostrema* with various subgenera and *Tinostoma* (*Teinostoma*) of which *Moerchia* and *Cirsonella* were considered subgenera.

In Australia, Tate (1899) followed Fischer and used the two families Liotiidae and Cyclostrematiidae to cover Australian species, the former for heavy cancellate shells approximating to the true *Liotia*, the latter for small shells with depressed spires, thin to vitreous in texture, lightly sculptured or smooth, and generally umbilicate, though some with the umbilicus closed by a sheet of callus.

Cyclostrematiidae used in this way is rather unfortunate, for the true *Cyclostrema* is a heavy, cancellate shell, approximating to *Liotia*, though more depressed and without the heavy varix. Bush (1897 : 99) recognized this when studying the American Atlantic species and states : " The family name Cyclostrematiidae constituted by Fischer should now be restricted to forms like the true *C.cancellata* Marryatt, and perhaps may prove to be closely related or synonymous with Liotiinae as used by Adams and Chenu, Liotiidae as used by Tryon or Delphinuliidae as used by Fischer and Dall."

In the same paper the author (p. 107) introduced Vitrinellidae to include *Vitrinella* C. B. Adams and " all small, more or less hyaline, non-nacreous species, varying in form, from those having a low spire and large umbilicus like *Circulus* to the higher spired genera like *Lissospira* and those with closed

* This research has been assisted by a grant from the Science and Industry Endowment Fund.

*34266—1

umbilicus like *Thassiella*". Again (p. 115): "There is a group of small, solid, nearly smooth, porcellanous shells which have been referred to *Ethalia*, *Calcelina*, *Teinostoma*, *Pseudorotella*, *Cirsonella* and *Dillwynia*. They all have the umbilical region wholly or in part covered with a callous deposit. The texture and callosity indicate closer affinity to the genus *Umbonium* Link (subfamily Umboniinae) rather than to the Vitrinellidae." Later American authors such as Bartsch (1907 and 1911) have used Vitrinellidae in the same sense.

In Australia again Hedley (1917) left the whole question in abeyance, and was content to use Liotiidae to cover all the debatable elements in the Peronian Province, with the exception of certain very minute, planoid, thin, sculptured shells. For these he accepted Orbitestellidae as introduced by Iredale in New Zealand (1917: 327). None of these has yet been recorded from north Australia, either Solanderian or Dampierian. The same course was followed by Powell (1946) for New Zealand shells and by Laseron (1954) when reviewing the Peronian species; also in the present paper.

The fact remains that throughout the world there is yet very little information on which to found a true classification. The minute size of many of the species makes investigation difficult. The majority have never been seen alive; nothing is known of their anatomy and life history, and even the operculum is rarely seen. Only long and painstaking research can solve many of the intricate problems involved. It is however suggested that from general characters, from the texture of the shells and their general facies, certain groups can be distinguished that, when further knowledge is gained, will prove to be several distinct families. Among these can be singled out as one the very minute genera *Liotella* and *Brookula* with their rounded whorls and sharp axial ribs. The curious genus *Liotropica*, described in this paper, seems unrelated to any other known shell. The exceedingly minute, algae-living *Helisalia* from the Peronian Province, with the appearance and texture of many land shells, almost surely belongs to a different family. The very thin, smooth, vitreous, transparent *Microdiscula* again seems to have little relationship with such genera as *Circlotoma* and *Caperella*, while *Callodix* and *Rotostoma* seem again different. A brief glance at the figured species of other parts of the world shows many parallel examples.

Generically and specifically the problem is a little less complicated. Shell characters are strong and well defined, and there is little variation in the species. Species are not difficult to determine, and they fall into distinctive small groups which have necessitated the proposal of a number of new genera, based mainly on general form, texture and type of sculpture. One or two of these have a general resemblance to European or Atlantic forms, but it is felt for reasons given in previous papers, that a too wide use of generic terms can be very misleading and lead to false conclusions on geographical distribution. Of the new genera proposed *Circlotoma* is the nearest to any extra Australian genus, and is not greatly different from *Circulus* Jeffreys, the type of which came from Sicily in the Mediterranean.

TYPES

All holotypes, paratypes and specimens illustrated have been placed in the Australian Museum.

DESCRIPTION OF SPECIES

Genus **Liochrysta**, gen. nov.

Type species: *Microtheca acidula* Melvill and Standen.

Shell of moderate size, turbinate, not heavy, sculpture both spiral and axial, the intersections rising into rounded gemmules, aperture oblique, peristome complete, the margins of the aperture thin without a varix, umbilicus deep, surrounded by a heavy basal rib or funicle.

Microtheca A. Adams was proposed with *Isanda crenellifera* A. Adams from Japan as type, and apart from the turbinate shape has little in common with *Liochrysta*. Compared with other genera *Liochrysta* differs from *Liotia* and *Austoliotia* by the thinner shell and absence of a varix, and from *Pseudoliotia* by the turbinate form.

Liochrysta acidula (Melvill and Standen)

(Figures 1-3)

Microtheca acidula Melvill and Standen, 1899: 177; pl. 10, figs. 10, 10a.

The type locality is Torres Strait. A number of specimens was sorted from the dredgings at 15-20 fm, Pt. Charles, Darwin, and also from the shore. The specimen illustrated has a maximum diameter of 6·2 mm and a minimum diameter of 5 mm. The abundance of the species at Darwin not only extends the range westwards but shows that it is truly Dampierian.

The characters are distinctive and it cannot be readily confused with any other Australian species. A notable feature is the large basal rib encircling the umbilicus.

Genus **Austroliotia** Cotton

Austroliotia Cotton, 1948 : 31.

Type species : *Liotina botanica* Hedley.

The type is a common Peronian species, and its generic position has always been open to doubt. *Liotina* Fischer (1885 : 831) is a European Eocene fossil, to which the Australian recent species *botanica* conforms in general characters. A feature in common not mentioned by Cotton is that the varix is heavy with an additional narrow rim on its face encircling the aperture. The form of the shell is depressed, the aperture free, twisted downwards and oblique, the sculpture is heavily cancellate and the umbilicus deep. Cotton describes the operculum as horny, multispiral, but with faint traces of granules.

In view of the great interval in time and distance the generic separation of Australian recent forms from those of the European Eocene is I think justified, and does not rule out any future discussion of their possible relationship.

Austroliotia botanica darwinensis subsp. nov.

(Figures 4-6)

The type locality of *Liotia botanica* Hedley (1914 : 710, pl. 81, figs. 46-48) is Sydney. The major diameter is given as 7 mm, but occasional specimens are still larger. In Hedley's Check List (1917) the species is listed under *Liotina* Fischer. A series from 15-20 fm off Pt. Charles, Darwin, after careful comparison with a series from Sydney, the type locality, cannot be separated specifically, but differ slightly by being uniformly smaller, and by having the axial ribs persistent throughout, whereas in typical *botanica* they become weakened, and on the base quite obsolete towards the aperture. In view of the extensive range some variation can be expected in the tropical specimens, sufficient to justify racial separation. So far the species has not been recorded from any intermediate locality. The major diameter of the specimen illustrated is 5 mm, its minimum diameter 4 mm.

Genus **Pseudoliotia** Tate

Pseudoliotia Tate, 1899 : 222

Type species : *Cyclostrema micans* A. Adams.

The characters of *Pseudoliotia* are the small, heavy shell with depressed spire and strong cancellate sculpture, the very oblique aperture with thickened margins but no varix, and the open, deep umbilicus. Tate describes the operculum as horny and multispiral.

The type locality of *C. micans* is South Australia. Several species occur in northern Australia, but Tate considered them all as variations of the one species.

Pseudoliotia gowllandi (Brazier)

(Figures 7-9)

Liotia gowllandi Brazier, 1874 : 672, pl. 83, figs. 1, 2.

There has been considerable confusion in the past as to the identity of this species. Tate (1899 : 223) reduced it to a variety of the South Australian *micans* which also ranges into New South Wales, and with which he synonymized the Peronian *speciosa* Angas. He used the term micromorphs to explain the difference in size, while differences in sculpture were attributed to individual variation. Later *speciosa* was restored by Hedley for the second Peronian species, but *micans* was generally used for specimens from Queensland, and so appears in Hedley's check list of Queensland mollusca (1909). Specimens in the Australian Museum from the Torres Strait, the type locality of *gowllandi*, are labelled as that species, but examination shows them to be the species here described as *P. tropica*.

The genus is very common at Darwin, both on the shore and in dredgings, and can readily be divided into four species, all of which are constant in size, form and sculpture. The difference in form can best be appreciated from the contour when laterally viewed, as can be seen from the figures now published. All differ from the two southern species by being less nodulose at the intersection of the spirals and axials. Of the four the one here figured can alone approximate to the true *gowllandi*, and to that species it is with some doubt referred. Its size is very nearly the same, the maximum diameter 2·2 mm, the minimum diameter 1·8 mm, and the sculpture is practically the same. Unfortunately the type of *gowllandi* is in London, and the published figures show the axials rather more numerous, and omit a figure of the lateral profile.

Features of *gowllandi*, apart from the form and size, are the vitreous and shining texture, the absence of fine spiral threads on or between the axial ribs, and the swelling of the axial ribs where they cross the spiral keels. Of the latter two are present on the upper surface of the whorls and three are visible on the base.

Pseudoliotia tropica sp. nov.

(Figures 10-12)

Shell small, very depressed, solid, vitreous, pure white. Protoconch naticoid, smooth and glassy, of about two whorls, the nucleus minute. Mature whorls three, increasing rapidly, flattened above and concave towards the suture, the spire visible when laterally viewed, nodulose at the sutures. Sculpture primarily of sharp, oblique axial ribs, rising and thickening slightly where they cross the upper spiral keel, below which they bend in to the peripheral keel, and from there evenly into the base. The axial ribs are crossed throughout, both above and on the base, by numerous, closely packed, spiral threads. Umbilicus round and deep. Aperture very oblique, thickened, with a secondary, sharp, raised inner rim. Maximum diameter 3 mm, minimum diameter 2·2 mm.

Localities.—Common in 15-20 fm, Pt. Charles, Darwin (Mel Ward), holotype and 9 paratypes selected; Darwin beaches (J. Laseron).

Remarks.—The species is also common in the Torres Strait area, where it has been labelled *gowllandi*. Compared with that species it is uniformly larger, more depressed, has a different lateral contour and fewer spiral keels. The fine spiral threads also distinguish it from that and other species.

Pseudoliotia axialis sp. nov.

(Figures 13-15)

Shell small, subturbinate, not greatly depressed, solid, vitreous, pure white. Protoconch relatively large, naticoid, of two whorls, the nucleus relatively large. Mature whorls two, rounded, with a narrow concave area adjacent to the sutures. Sculpture primarily of strong, oblique, rounded, smooth axial ribs, about their own width apart, and separated by deep channels. Spiral threads absent. On the upper surface one strong, rounded spiral keel parallels the suture. This is crossed by the axial ribs, where they thicken, and then cross a concave depression to thicken again on the periphery, thence evenly across the base to terminate abruptly on the margin of the umbilicus which is round and deep. Aperture very oblique, entire, the margins thickened, with a narrow, raised, secondary aperture within. Maximum diameter 2·5 mm, minimum diameter 2·1 mm.

Locality.—Darwin beaches (J. Laseron), holotype and one paratype selected.

Remarks.—This is the deepest of all the species, and is easily recognized by the strong, smooth axial ribs, and the presence of only one spiral keel.

Pseudoliotia liliputia sp. nov.

(Figures 16-18)

Shell minute, depressed, spire just visible laterally, solid, vitreous and white. Protoconch naticoid, of about 1½ whorls, rounded, smooth and vitreous, nucleus relatively large. Mature whorls two, rounded, concave near the suture. Sculpture of strong, rounded, oblique axial ribs, separated by deep furrows, rising where they cross the spiral keels into rounded nodules. The spiral keels are prominent and rounded, one on the summit parallel to the suture, two even keels on the periphery, giving the shell a distinct lateral profile, and two more on the base, the lowest bordering the deep, round umbilicus. Aperture as in other species very oblique, entire, the margin thickened and with a secondary, thin, raised inner aperture. Maximum diameter 1·5 mm, minimum diameter 1·2 mm.

Locality.—Darwin beaches (J. Laseron), common, holotype and eight paratypes selected.

Remarks.—This is the smallest of the species so far described. In form and sculpture it approaches nearest to *P. gowllandi* as here interpreted, but it differs not only in size but in the number and disposition of the spiral keels, the two peripheral keels giving it a distinctive lateral contour.

Genus **Discreliotia** gen. nov.

Type species: *Discreliotia radians* sp. nov.

Shell small, solid, turbinate, aperture oblique, peristome entire, margins reflected, without a varix, umbilicus closed by callus and bordered by a heavy double rib which covers nearly half the base. Sculpture discrepant, the upper portion nearly smooth except for a spiral keel, one half of the base with heavy axial ribs, the other half towards the aperture occupied by the heavy funicular rib.

The turbinate form, closed umbilicus and the curious discrepant sculpture are the main characteristics of this genus.

Discreliotia radians sp. nov.

(Figures 19-21)

Shell small, solid, turbinate, white and opaque. Protoconch naticoid, of two whorls, smooth and glassy. Mature whorls three, descending in sharp steps, the earlier whorls flattened above with vertical sides. Sculpture discrepant, the upper surface flattened adjacent to the sutures, thence a sharp spiral keel, below which the surface descends in a concave curve to a narrow platform above a sharp peripheral keel. Faint spiral threads fill this space. On the base half the surface is filled by from 9 to 10 strong, rounded axial ribs, about their own width apart, converging into the closed umbilicus. The axial ribs disappear about half way to the aperture, to be replaced externally by another sharp, spiral keel, equally prominent with the peripheral keel. Below is another strong, rounded basal rib or funicle which surrounds and completely fills what would be the umbilical cavity. Aperture oblique, the margins truncate, a secondary rounded aperture within with a raised outer rim and thickened within. Maximum diameter 3·5 mm, minimum diameter 2·9 mm.

Locality.—15-20 fm off Pt. Charles, Darwin (Mel Ward), holotype and six paratypes.

Remarks.—The remarkable sculpture of this novelty is so distinctive that it cannot be confused with any other known species.

Discreliotia serrata sp. nov.

(Figures 22-24)

Shell small, solid, turbinate, white. Protoconch naticoid, of two whorls, smooth and glassy. Mature whorls three, similar in form to those of *D. radians*. Sculpture of one sharp keel on the summit of the whorl, with two equal keels on the periphery, the spaces between concave and nearly smooth, but the keels slightly serrated, particularly near the aperture. Base without the strong axial ribs of *D. radians* which are replaced by faint axial threads. The strong basal rib or funicle bordering a closed umbilical depression is, however, crossed by ill-defined axials. Umbilical cavity shallow, closed by a tongue of callus from below the inner margin of the aperture. Aperture oblique, as in *D. radians* with a secondary rim developed within the truncate margins. Maximum diameter 3·5 mm, minimum diameter 2·8 mm.

Locality.—15-20 fm off Pt. Charles, Darwin (Mel Ward), holotype.

Remarks.—In form and aperture this is nearly identical with *D. radians*, but the two peripheral keels are persistent to the aperture, and the basal axial ribs are absent except where they indent the basal rib surrounding the umbilical cavity. A minute species from Funafuti, *Liotia parvissima* Hedley (1899 : 554, fig. 57) conforms in form and partially in sculpture with both *radians* and *serrata*, but has a heavy varix and a deep umbilicus.

Genus **Lioprora** gen. nov.

Type species : *Liotia rostrata* Hedley.

Shell small, discoidal, flat above and rounded below, sculpture both axial and spiral, widely umbilicate, peristome completed by a heavy band of callus on the body whorl, outer margin of aperture terminating in a heavy solid spur or beak, to varix, aperture oblique.

This is another of the peculiar Australian shells which will not readily fit into any known genus. Hedley in his descriptions of such new Queensland species more than once expressed doubts of their generic identity, but was content to assign them either to *Liotia* or *Teinostoma*, where they were equally out of place. The rostrate aperture of *Lioprora* should alone be sufficient to establish its generic identity.

Lioprora rostrata (Hedley)

(Figures 25-27)

Liotia rostrata Hedley, Aug. 1900 : 502, pl. 26, figs. 4-7.

The type locality is off Cape York, Torres Strait. The specimen here figured is one of two collected at Darwin (J. Laseron) and extends the range westwards, at the same time showing the species to be a constituent of the Dampierian fauna. Its maximum diameter is 3 mm and the minimum diameter 2·5 mm. The Darwin specimens agree very well with Hedley's excellent figure and description, and the characters as outlined in the generic description leave no doubt as to its identity.

Genus **Circumstella** gen. nov.

Type species : *Liotia devexa* Hedley.

Shell small, flat above with a low, turreted spire, sculpture primarily of strong spiral keels, axial sculpture also present, aperture detached, oblique, twisting downwards, with a heavy double varix. Umbilicus deep, rendered stellate by sharp, angular ribs, separated by deep pits, which descend right within the cavity. The last character is very distinctive and gives a decided facies to the genus.

Circumstella devexa (Hedley)

(Figures 28-30)

Liotia devexa Hedley, 1901 : 18, pl. 2, figs. 4-6.

The type was dredged in Torres Strait, and a series from 15-20 fm off Pt. Charles, Darwin, now extends its range well into the Dampierian Province. The specimen figured has a maximum diameter of 4·5 mm and a minimum diameter of 3·8 mm. Again the characters as outlined in the generic description, particularly the large stellate umbilicus, are so distinctive that its recognition is very easy.

Genus **Liotella** Iredale

Liotella Iredale, 1914 : 442

Type species : *Liotia polypleura* Hedley.

Minute shells, depressed, often coiled in one plane, whorls round, apertures without a varix, round and oblique, often quite free, umbilicus wide, sculpture of sharp axial ribs encircling the whorls, fine spiral threads or striae sometimes present.

The genus is so far known only from New Zealand and Australian waters. The description of a number of species by Laseron (1954) from the Peronian Province shows that the group is a large and complex one, and a further subdivision may yet be necessary. Within the genus one small group of three species seem closely allied, and could perhaps form the basis of still another genus. These are *Liotella pulcherrima* (Brazier) from Sydney, the Queensland species *Liotia anxia* Hedley (1909 : 437, pl. 39, figs. 43-45), and a new species *Liotella elegans* now described from Darwin. All have flattened spires, very fine sculpture, with the aperture quite detached and twisting downwards.

Liotella elegans sp. nov.

(Figures 31-33)

Shell exceedingly minute, spire depressed below the surrounding whorls, uncoiled in later stage, white. Whorls three, round. Sculpture of fine, rounded, axial ribs, about their own width apart, completely surrounding the whorls, about 35 on the body whorl, no spiral sculpture detected. Aperture round, free and detached, twisted downwards and oblique, margins thin. Umbilicus wide and shallow. Maximum diameter ·6 mm.

Locality.—Darwin beaches (J. Laseron), holotype.

Remarks.—This species is closely related to the Peronian *L. pulcherrima* (Brazier) and the Solanderian *L. anxia* (Hedley), but has an even more depressed spire and slightly coarser sculpture. In size it is amongst the smallest shells known.

Genus **Liotropica** gen. nov.

Type species : *Moerchia introspecta* Hedley.

Shell minute, solid, coiled loosely in one plane, the whorls flattened and angled with the wide, flattened base, widely umbilicate, sculpture finely axial, the aperture with a prominent varix, free and so twisted downwards as to be almost in the plane of the base.

Moerchia or *Morchia* (Adams uses both spellings) was described as a subgenus of *Cyclostrema* with *C. obvulata* A. Adams from Japan as type (A. Adams, 1863 : 74). Though most of the characters of *Liotropica* conform to *Moerchia* it is separated by the flattened whorls, flattened base and extremely twisted aperture. It has such a distinctive facies that it may later be necessary to transfer it to a new family.

Liotropica introspecta (Hedley)

(Figures 34-36)

Moerchia introspecta Hedley, 1907 : 493, pl. 20, figs. 47-49.

The type locality is 17-20 fm off Masthead Island, Queensland, the major diameter of the type 2·25 mm, the minor diameter 1·6 mm. Three specimens from Darwin (J. Laseron) are slightly smaller, the maximum diameter of that figured being 1·8 mm, the minimum diameter 1·4 mm. Otherwise they conform in all characters despite the great extension of the range. Hedley's excellent figures and description leave little to be added, and the very distinctive form makes it easy to recognize.

Genus **Circlotoma** gen. nov.

Type species : *Circlotoma rotata* sp. nov.

Shell small, depressed to discoidal, of thin to medium texture, aperture oblique, thin and without a varix, peristome incomplete, but sometimes made continuous by a thin callus on the body whorl, inner margin reflected to form a pillar, umbilicus round and deep. Sculpture predominantly of spiral keels, axial sculpture when present faint, but sometimes making one or more of the keels slightly serrate or tuberculate.

Among the American Atlantic fauna Bush (1897) uses *Circulus* Jeffreys for a somewhat similar group of shells, and Bartsch (1907 and 1911) uses the same genus widely for species from the West American Pacific species. From the illustrations some of these have little relationship with each other. From Darwin five species are assigned to *Circlotoma*, but though all conform to the characters given, they too show different facies which, as more species are discovered, may necessitate further generic revision. This applies particularly to the two species here discussed as *C. planorbis* sp. nov. and *C. venusta* (Hedley).

Circlotoma rotata sp. nov.

(Figures 37-39)

Shell small, solid, depressed, white. Protoconch with a minute nucleus, and about 1½ flat, smooth, glassy whorls, mature sculpture beginning gradually. Mature whorls three, rounded, the spire depressed but visible laterally, sutures slightly channelled. Sculpture of eight evenly spaced, rounded spiral ribs, five visible from above and four from below. Aperture without a varix, oblique, the peristome incomplete, but with a band of callus on the body whorl, the margins thin, indented by the keels, inner margin slightly reflected, umbilicus wide and deep. Maximum diameter 2·5 mm, minimum diameter 2·2 mm.

Localities.—Darwin beaches (J. Laseron), holotype and 14 paratypes selected; also abundant in the dredgings 15-20 fm off Pt. Charles, Darwin (Mel Ward).

Remarks.—This is one of the commonest species at Darwin, and may be considered a definite unit of the Dampierian fauna.

Circlotoma callusa sp. nov.

(Figures 40-42)

Shell small, solid, subturbinate, white and translucent. Protoconch flat with a minute nucleus, of about 1½ smooth, glassy whorls, mature sculpture beginning gradually. Mature whorls three, rounded, sutures channelled. Sculpture of about 14 narrow, rounded spiral keels, evenly spaced, about 10 visible from above, and 5 to 6 below the periphery where they become very faint, remainder of base smooth and shining. Aperture oblique, peristome completed by a band of callus on the body whorl, outer margin thin, inner margin, ill-defined and rounded, merging into a smooth callus on the body of the shell. Umbilicus round, narrow and deep. Maximum diameter 3·5 mm, minimum diameter 3·2 mm.

Locality.—Darwin (J. Laseron), holotype and one paratype.

Remarks.—Compared with *C. rotata* this is a larger shell, less depressed in shape, with finer sculpture, a smaller umbilicus, and a slightly different aperture. Of the Australian species it is the nearest to the type species of *Circulus* Jeffreys *C. duminyi* (Requien) which was described from Sicily.

Circlotoma venusta (Hedley)

(Figures 43-45)

Liotia venusta Hedley, 1901 : 17, pl. 3, figs. 1-3.

The type locality is Darnley Island, Queensland, the dimensions given : major diameter 4·9 mm, minor diameter 3·8 mm. A number of specimens from 17 to 20 fm, Pt. Charles, Darwin (Mel Ward) agree very well with the type, the one figured having a maximum diameter of 5·4 mm and a minimum diameter of 4·2 mm. *C. venusta* and *C. transculpta*, sp. nov., are evidently allied, though differing in details of form and sculpture. Together they form a group within *Circlotoma* distinguished by the presence of axial sculpture. It is surprising that Hedley did not give a new generic name to his species as he remarks : " This species is not like the typical *Liotia*; it possibly belongs to *Microtheca* A. Adams, a genus not sufficiently elaborated by its author for satisfactory use ".

Circlotoma transculpta sp. nov.

(Figures 46-48)

Shell small, moderately solid, depressed, the spire just visible laterally, white. Protoconch naticoid, nucleus small, of about two whorls, smooth and glossy, mature sculpture beginning gradually. Mature whorls three, flattened above, sutures deep, margins rounded. Sculpture predominantly spiral, the flattened portion above with a median thin keel, the bordering keel stronger. Below this the spirals are sharp, closely packed, and cover the base to the margin of the deep, round umbilicus. Axial sculpture is present, breaking the upper marginal keel into sharp serrations, evenly spaced, and about 25 to the whorl. Apart from these, fine axial threads cover the whole shell, and on the base particularly make the sculpture minutely clathrate. Aperture oblique, peristome incomplete, a thin line of callus on the body whorl, outer margin thin and indented by the sculpture, inner margin straight and slightly reflected. Maximum diameter 3·5 mm, minimum diameter 2·9 mm.

Locality.—17-20 fm off Pt. Charles, Darwin (Mel Ward), holotype.

Remarks.—In general form this approaches *C. callusa*, but is more depressed and differs also in the sculpture and aperture.

Circlotoma planorbis sp. nov.

(Figures 49-51)

Shell small, very flat, spire depressed below the body whorl, texture thin, vitreous and translucent. Whorls three following a minute nucleus. Sculpture of sharp spiral keels, six in all, one midway on the upper surface, two peripheral and three on the base. The uppermost keel is sharp and raised, descending with a steep, concave surface to the suture. A similar concave space separates it from the peripheral keel. The two peripheral keels are subequal, the basal keels are slight except the one encircling the wide, deep umbilicus. Aperture oblique, polygonal, the margins thin, indented by the sculpture, the peristome incomplete with a faint line of callus on the body whorl, inner margin slightly reflected. Maximum diameter 3 mm, minimum diameter 2·5 mm.

Locality.—17-20 fm off Pt. Charles, Darwin (Mel Ward), holotype and one paratype.

Remarks.—Though conforming to the characters of the genus as defined, the thin, translucent texture suggests it may have other relationship. It is the flattest of the species here discussed, and the form and sculpture are distinctive.

Genus **Moeniatoma** gen. nov.

Type species : *Moeniatoma diamura* sp. nov.

Shell small, solid, white and translucent, flattened above, aperture descending, oblique, peristome complete, margins thin, the base with a deep round umbilicus bordered by a very heavy double rib or funicle. Sculpture of a few, sharp spiral keels.

This again is one of the curious little Australian genera which will not fit into any of the older recognized genera. The complete peristome and heavy basal rib distinguish it from such genera as *Circlotoma* and *Caperella*.

Moeniatoma diamura sp. nov.

(Figures 52-54)

Shell small, very depressed, moderately solid, white, vitreous and translucent. Protoconch of a small, rounded, glassy nucleus, followed by about 2½ mature whorls. Mature whorls angulated, a sharp, raised spiral keel on the summit, descending concavely to the suture, and with a steep, concave surface to a sharp peripheral keel. Base excavate below the peripheral keel with two further sharp, basal keels combining to form a large rib or funicle surrounding the round, deep umbilicus. Aperture oblique, the peristome complete, margins uniformly thin. Maximum diameter 2·9 mm, minimum diameter 2·3 mm.

Locality.—Darwin (J. Laseron), holotype.

Remarks.—The texture, simple sculpture, and the large basal rib which gives a distinctive lateral contour are all good recognition points. There is no other Australian species with which this can readily be confused.

Genus **Callodix** Laseron

Callodix Laseron, 1954 : 16

Type species : *Callodix solida* Laseron.

The type is a Peronian species, and the characters considered generic were the small, depressed shell with fine spiral sculpture and the greatly developed striate callus covering the base and extending posteriorly above the aperture upon the spire. The discovery of a second species at Darwin, now described as *C. conica*, extends the range of this genus well around Australia, and it is probable that the same or further species will be found in intermediate localities.

Callodix conica sp. nov.

(Figures 55-57)

Shell minute, solid, broadly conical, white and translucent. Whorls three, body whorl rounded, nearly flat above, sutures very shallow. Sculpture of fine, closely packed spiral cords, evenly spaced, about their own width apart. Aperture rounded, oblique, outer margin thin, inner margin thickened by a heavy callus which spreads over the umbilical area in a thick plate crossed by fine threads, and upwards on the spire, the covering threads there coincident with the sculpture, to merge eventually into the earlier whorls. Maximum diameter 1·7 mm, minimum diameter 1·3 mm.

Locality.—Beach at Darwin (J. Laseron), holotype.

Remarks.—Compared with the type species *C. solida*, the more conical shell and the even greater development of the extraordinary callus at once distinguish this novelty, and there is no other known species with which it can readily be compared.

Genus **Tholostoma** gen. nov.

Type species : *Tholostoma carinata* sp. nov.

Shell minute, turbinate, fairly solid, vitreous in texture, translucent, the whorls domed above but with peripheral keels, other sculpture faintly spiral, umbilicate, aperture oblique with thin margins, the peristome completed by a layer of callus on the body whorl.

This is another minute gasteropod whose systematic position is uncertain. Most of the characters as defined conform to *Caperella*, but the turbinate form and the domed whorls give it a very different facies, and there is probably little real relationship.

Tholostoma carinata sp. nov.

(Figures 58-60)

Shell minute, turbinate, fairly solid, vitreous, white and translucent. Whorls four, including a small naticoid protoconch indistinguishable from the mature shell. Whorls domed above, excavate below, the sutures deep. Sculpture of two strong, narrow, equal, rounded peripheral keels, separated by a slightly concave area, with four faint, spiral keels on the base surrounding the narrow but deep umbilicus. Very faint spiral threads also occur on the upper portion of the whorls, and adjoining the suture there is a row of faint axial nodules. Aperture oblique, the peristome completed by a thick band of callus on the body whorl, margins thin. Maximum diameter 1·3 mm, minimum diameter 1 mm.

Locality.—Beaches at Darwin (J. Laseron), holotype and one paratype.

Remarks.—The turbinate form, domed upper surface of the whorls and the strong peripheral keels should aid the future recognition of this species, and there is no other Australian species with which it can readily be compared.

Genus **Caperella** gen. nov.

Type species : *Teinostoma orbitum* Hedley.

Shell of medium size, flat and discoidal, fairly solid, porcellanous, white, sutures shallow. Aperture as in *Circlotoma* oblique, the peristome incomplete, a line of callus on the body whorl, but the reflected inner margin produced into a spur which overhangs and may partially fill the round deep umbilicus. Sculpture when present very fine, of spiral threads crossed by faint growth lines. Weak axial ribs may be present on the earlier whorls.

Hedley (April, 1900) assigned the type species to *Solariorbis* Conrad as a subgenus of *Teinostoma* A. Adams, an American group with somewhat similar characters. *Teinostoma*, sensu stricto, has a smooth, highly polished shell, an elongated aperture and a thick callus covering the whole of the umbilical area.

Caperella orbitum (Hedley) ?

(Figures 61-66)

Teinostoma (*Solariorbis*) *orbitum* Hedley, Apr. 1900 : 96, pl. 3, figs. 13-15.

This species is identified with some uncertainty, as all the Darwin material is slightly worn and shows minor variations from the type. The type came from Torres Strait and the species is also found on the north Queensland coast. The main differences of the Darwin specimens are in the degree of angulation at the periphery of the whorls, in the development of the basal spur and to a slight extent in the obliquity of the aperture. Tentatively they may also be divided into two series, but more and better material is needed to decide if the difference is sufficient to justify racial or specific separation.

Figs. 61 to 63 are of a specimen from 15-20 fm off Pt. Charles, Darwin, its maximum diameter 5·3 mm and minimum diameter 4·5 mm. In this specimen the characters of the base, the spur and nearly closed umbilicus correspond closely to typical *orbitum*, but the peripheral angulation is very marked, and there is a distinct but narrow keel. Several specimens from the shore collections are very close to this, but show only a trace of the peripheral keel. From these another series of shore specimens can be separated by having no peripheral keel at all, the whorls are practically rounded, the umbilicus is more open owing to a lesser development of the basal spur, the aperture is not so oblique and its outer margins are thicker and truncate. One is here figured (figs. 64 to 66). Its maximum diameter is 5 mm and the minimum diameter 4·2 mm. The sculpture is sometimes very faint, but is uniformly of fine spiral threads crossed by axia threads with slight axial ribs on the earlier whorls.

Caperella umbilicata sp. nov.

(Figures 67-69)

Shell of medium size, solid, depressed, flattened above, rounded below, white. Protoconch distinct from mature shell, of three whorls, nucleus minute, smooth, glassy and rounded. Mature whorls three, flattened above, rounded below, angled at the periphery, sutures shallow. Sculpture of numerous, low, rounded spiral ribs separated by narrow furrows, about twelve visible from above, with as many more on the base. These are crossed by fine axial threads, and on the earlier whorls by low, broad axial ribs. On the base the spiral ribs persist into the round, deep umbilicus. Aperture very oblique, peristome incomplete, outer margin thin, inner margin reflected and produced as a narrow spur bordering the open umbilicus. Maximum diameter 4·1 mm, minimum diameter 3·5 mm.

Locality.—15-20 fm off Pt. Charles, Darwin (Mel Ward), holotype and three paratypes.

Remarks.—This species is very close to *C. orbitum* in both form and sculpture, but the peripheral angulation is constant, as is the large, open umbilicus. The latter character is considered of sufficient importance to warrant specific separation.

Genus **Peripitoma** gen. nov.

Type species : *Peripitoma vitrea* sp. nov.

Shell small, fairly solid, depressed turbinate, vitreous and translucent, smooth and polished, umbilicus large and deep. Aperture oblique, peristome incomplete, a heavy callus on the body whorl, a shallow channel on the base from the aperture to within the umbilicus.

In general form *Peripitoma* resembles *Caperella*, but it is quite smooth and lacks the basal spur. It also corresponds in form to the minute southern genus *Lissotesta*, but is much heavier and more solid.

Peripitoma vitrea sp. nov.

(Figures 70-72)

Shell small, depressed turbinate, fairly solid, vitreous, translucent, white. Whorls four, including a small nucleus, evenly rounded to the sutures and below to the deep broad umbilicus the margin of which is angled. Sculpture absent, the surface smooth and shining. Aperture oblique, peristome incomplete, but joined by a thick band of callus on the body whorl, margins truncate, without a varix, the inner margin angled where it is indented by a wide, shallow, spiral furrow which at first borders and then extends within the umbilicus. Maximum diameter 3·5 mm, minimum diameter 2·8 mm.

Locality.—Darwin (J. Laseron), holotype and four paratypes.

Remarks.—The only known Australian species with which this can be compared are members of the southern genus *Lissotesta*, which all have thin, fragile shells and are more turbinate in shape. The peculiar basal furrow is also distinctive.

Genus **Rotostoma** Laseron

Rotostoma Laseron, 1954 : 15

Type species : *Ethalia brazieri* Angas.

Rotostoma was proposed for minute, solid, white, smooth and highly polished shells approximating the true *Teinostoma* A. Adams, with a callus covering the umbilical area, the aperture very oblique and without a varix, the peristome incomplete but a heavy band of callus on the body whorl. The basal callus is not as heavy as in *Teinostoma*, the aperture is shorter and not angulate. From *Callomphala* Adams & Angas it differs chiefly by the absence of a varix. When something is known of the animal this group of genera may well prove to be quite a separate family.

Rotostoma impleta sp. nov.

(Figures 73-75)

Shell very small, depressed, solid, vitreous, white and translucent. Protoconch with small globose nucleus, followed without break by the three mature whorls. These are rounded, tightly coiled without sculpture, smooth and highly polished, sutures very shallow and hardly distinguishable. Aperture oblique, the margins thin and even, peristome incomplete, but connected by a heavy band of callus on the body whorl, this callus spreading over the base and filling the umbilicus which is marked by a very shallow depression. Maximum diameter 2·2 mm, minimum diameter 1·7 mm.

Locality.—Darwin beaches (J. Laseron), very common, holotype and about forty paratypes selected.

Remarks.—This resembles the type species *R. brazieri* (Angas), which is a Peronian form, in general characters, but is much more depressed, and lacks the faint spiral sculpture on the summit of the whorls.

Genus **Circulter** gen. nov.

Type species : *Circulter acuta* sp. nov.

Shell small with a depressed, disc-like form, acutely angled at the periphery, texture thin, vitreous and translucent, surface smooth and polished, aperture only slightly oblique, extended, triangular, peristome incomplete, margins thin, inner margin straight and slightly reflected, umbilicus narrow and deep.

With other small, very thin, glassy shells of flattened form the systematic position of *Circulter* is very uncertain, and until something is known of the animal and operculum this must remain in abeyance.

Circulter acuta sp. nov.

(Figures 76-78)

Shell minute, very depressed, disc-like and involute, vitreous, thin and fragile, white and translucent. Whorls four, including the protoconch which is indistinguishable from the mature shell but has a minute nucleus. Mature whorls flattened and very slightly rounded above and below with a very acute peripheral keel, the sutures slightly channelled. Sculpture absent, the surface smooth and shining. Umbilicus narrow, round and deep. Aperture an elongated triangle, peristome incomplete, outer margins thin, inner margin straight, sharply angled anteriorly slightly reflected bordering the umbilicus. Maximum diameter 1·9 mm, minimum diameter 1·6 mm.

Locality.—Darwin beaches (J. Laseron), holotype and two paratypes.

Remarks.—The smooth, fragile, disc-like shell with its acutely angled periphery and triangular aperture should make the future recognition of this species easy.

Genus **Microdiscula** Thiele

Microdiscula Thiele, 1912, Deutsch Sud. Pol. Exped., 12 : 199

Type species : *Microdiscula vanhoffeni* Thiele.

Shell small, very thin and fragile, transparent, flattened, involute, smooth, the aperture more or less oblique, peristome incomplete, the umbilicus wide and shallow.

The type is a subantarctic species from Kerguelen, its shell characters conforming to the European *Skenea* from which Thiele separated it by the radula. In the absence of further data three Peronian species were attributed by Laseron (1954) to *Microdiscula*, and now three additional species from Darwin are rather doubtfully added. The only difference in shell characters is that the Darwin species all have the apertures more oblique. From the subantarctic to the tropics is rather an unusual range for a genus, and it is probable that further knowledge will show the relationship to be more apparent than real.

Microdiscula involuta sp. nov.

(Figures 79-81)

Shell minute, flat, coiled in one plane, partially involute, the spire completely visible from below, very thin and fragile, vitreous and transparent. Whorls four, including a minute nucleus, rounded, sutures deep. Sculpture absent, the surface smooth and shining. Base concave rather than umbilicate, all the earlier whorls visible. Aperture oblique, peristome incomplete, but a thin line of callus on the body whorl, the margins thin. Maximum diameter 1·9 mm, minimum diameter 1·6 mm.

Locality.—Darwin beaches (J. Laseron), holotype and one paratype.

Remarks.—Of the three species here described and of the Peronian species *M. fragilis* Laseron, this is the most involute, and shows less difference between the upper and lower surfaces of the shell.

Microdiscula planorbis sp. nov.

(Figures 82-84)

Shell relatively large, very flat, coiled nearly in one plane, the spire descending so that the upper margin of the aperture is just below the summit of the preceding whorl, very thin, colourless and transparent. Whorls four including a small nucleus, rounded, oval in section, the sutures deep. Base broadly umbilicate, with steep inner sides, the earlier whorls showing within. Aperture very oblique, subangled below, the peristome incomplete, but with a thin line of callus on the body whorl, margins thin. Sculpture absent except for microscopic growth lines, the surface shining. Maximum diameter 4 mm, minimum diameter 3·5 mm.

Locality.—Darwin beaches (J. Laseron), holotype and one paratype.

Remarks.—This is the largest of the Australian species and is also the most compressed.

Microdiscula augmenta sp. nov.

(Figures 85-87)

Shell minute, depressed, the spire descending slightly so that the upper margin of the aperture is just below the summit of the preceding whorl, the earlier whorls just visible when viewed laterally, very thin, vitreous, colourless and transparent. Whorls four including a minute nucleus, increasing rapidly so that the body whorl is relatively large, rounded, sutures not deep. Sculpture absent, the surface smooth except for microscopic growth lines. Base widely umbilicate, earlier whorls partly hidden. Aperture very oblique, relatively large, peristome incomplete, a line of callus on the body whorl, margins thin, inner margin nearly straight. Maximum diameter 2 mm, minimum diameter 1·7 mm.

Locality.—Darwin beaches (J. Laseron), holotype and two paratypes.

Remarks.—Apart from the difference in contour this species can be readily distinguished from the others here discussed by the relatively large body whorl and aperture. Reference to the figures will show the differences between the species much better than mere description.

NEW GENERA

The following new generic names have been proposed in this paper : *Caperella*, *Circlotoma*, *Circumstella*, *Circulter*, *Discreliotia*, *Liochrysta*, *Lioprora*, *Liotropica*, *Moeniatoma*, *Peripitoma*, *Tholostoma*.

ACKNOWLEDGMENTS

In this as in previous papers the author is deeply indebted to Mr. Tom Iredale who has assisted him throughout with advice and encouragement. In addition, Mr. Iredale sorted all the relevant specimens from the material dredged by Mr. Mel Ward from Darwin; in itself no mean task. To his son, John, the author is also deeply indebted for the extensive collections made at Darwin under considerable difficulties during the war years. The use of the Australian Museum library and access to the collections has also greatly facilitated the research, and for this thanks are due to Dr. J. W. Evans, Director, and Dr. D. F. McMichael, the Museum's conchologist.

REFERENCES

ADAMS, A. 1863. On the genera and species of Liotinae in Japan. *Proc. Zool. Soc. Lond.* 71-76.

ADAMS, H. and A. 1858. Genera of recent Mollusca. John van Voorst, London.

BARTSCH, Paul, 1907. New vitrinellid molluscs. Bull., 1785 *Proc. U.S. Nat. Mus.* 32 : 167-176.

BARTSCH, Paul, 1911. West American vitrinellids. Bull., 1785, *Proc. U.S. Nat. Mus.* 39 : 229-234.

BRAZIER, J. 1874. Description of new Australian shells. *Proc. Zool. Soc. Lond.* 668-672.

BUSH, Kath. 1897. Revision of Cyclostrema and related genera of the Atlantic Fauna of America. *Trans. Connecticut Acad.* 97-144.

COTTON, B. C. 1948. Southern Australian gasteropods, Pt. 3. *Trans. Roy. Soc. S. Aust.* 30-32.

FISCHER, P. 1887. Manuel de Conchyliologique, Paris.

HEDLEY, C. 1899. Mollusca of Funafuti, Supplement. *Mem. Aust. Mus.* 3(9) : 549-565.

HEDLEY, C. Apr. 1900. Studies on Australian Mollusca No. 1. *Proc. Linn. Soc. N.S.W.* 24 (1) : 87-100.

HEDLEY, C. Aug. 1900. Studies on Australian Mollusca No. 2. *Proc. Linn. Soc. N.S.W.* 24 (3) : 495-513.

HEDLEY, C. 1901. Studies on Australian Mollusca No. 4. *Proc. Linn. Soc. N.S.W.* 25 (1) : 16-25.

HEDLEY, C. 1907. Mollusca of Masthead Reef. *Proc. Linn. Soc. N.S.W.* 32 (3) : 476-523.

HEDLEY, C. 1909. Catalogue of the marine Mollusca of Queensland. *Rep. Aus . Ass. Advanc. Sci.* 12 : 343-372.

HEDLEY, C. 1914. Studies on Australian Mollusca No. 12. *Proc. Linn. Soc. N.S.W.* 39 (4) : 695-725.

HEDLEY, C. 1917. Check List of Marine Fauna of New South Wales. Part 1, Mollusca. *J. Roy. Soc. N.S.W.* Supplement 51.

IREDALE, T. 1914. Commentary on Suter's Manual of New Zealand Mollusca. *Trans. N.Z. Inst.* 47 : 417-497.

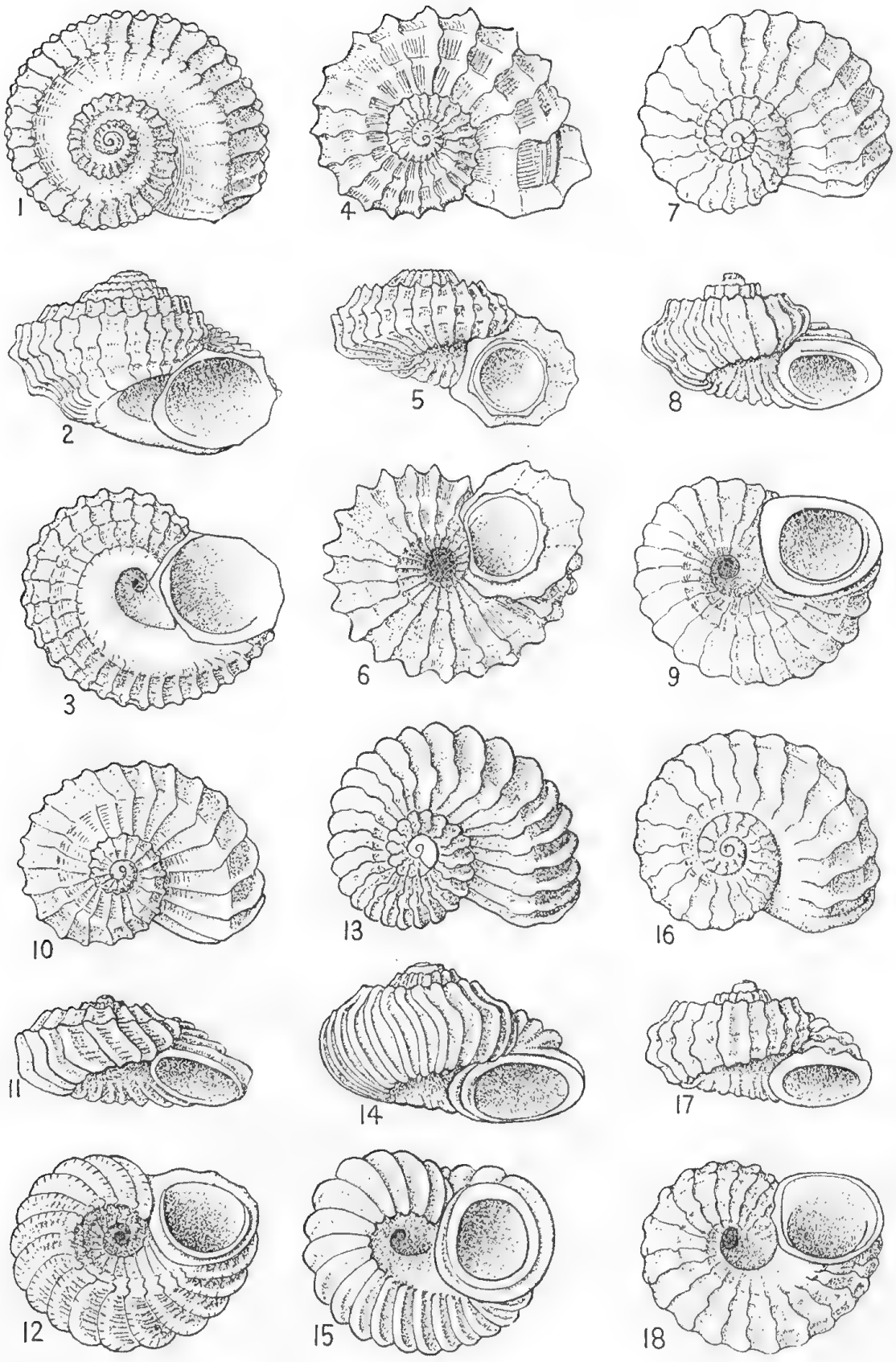
IREDALE, T. 1917. More molluscan name changes, generic and specific. *Proc. Malac. Soc. Lond.* 12 : 332-330.

LASERON, C. F. 1954. Revision of Liotiidae of New South Wales. *Aust. Zoologist* 12 (1) : 1-19.

MELVILL, J. C. and STANDEN, R. 1899. Mollusca of Torres Straits. *J. Linn. Soc. Lond. Zoology.* 27: 150-206.

POWELL, A. W. B. 1946. The shellfish of New Zealand, 2nd Edit. Whitcomb and Tombs.

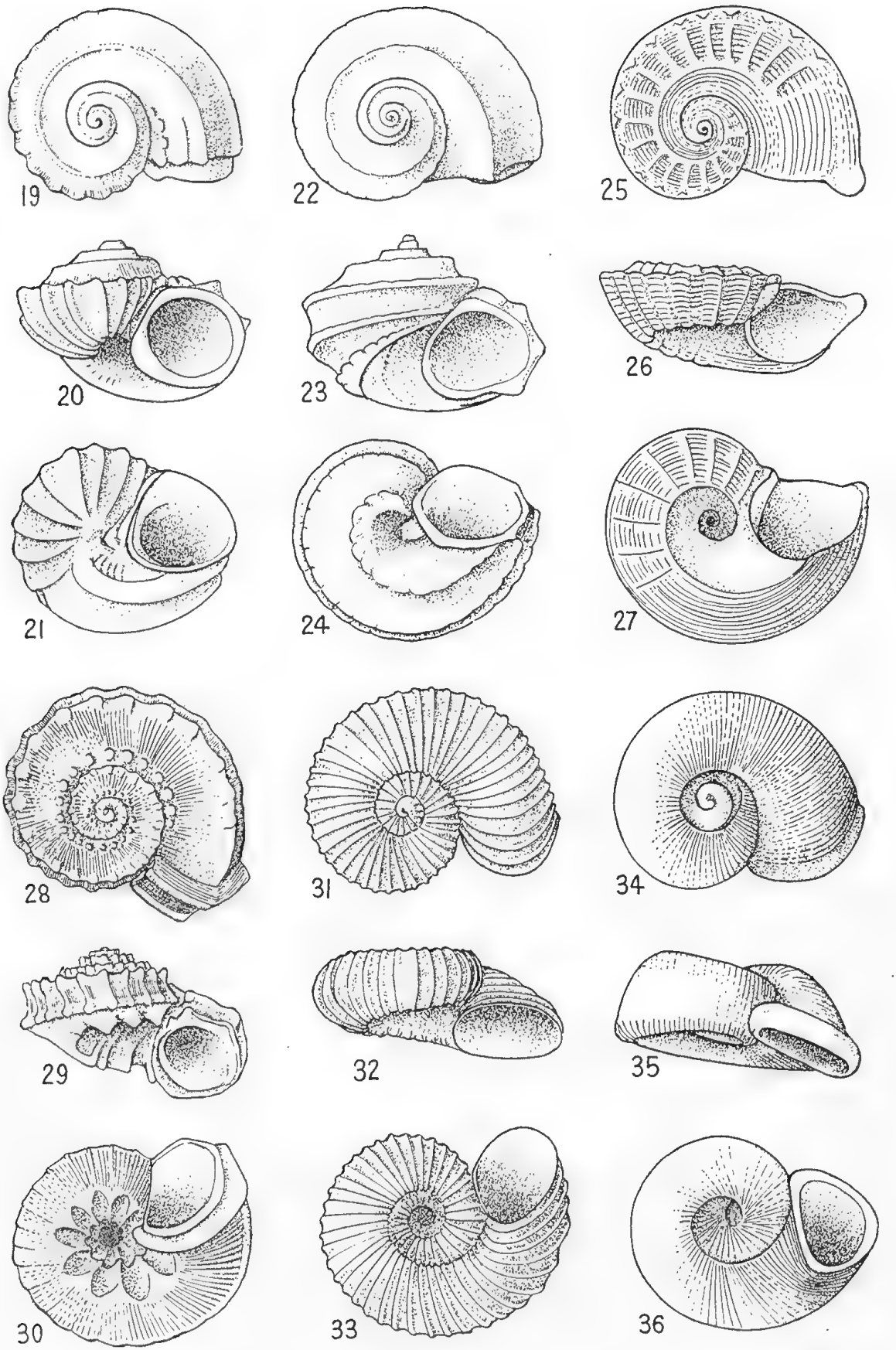
TATE, R. 1899. Revision of Australian Cyclostrematiidae and Liotiidae. *Trans. Roy. Soc. S. Aust.* 22 (2) : 223-230.



C. F. LASERON DEL.

FIGURES 1 TO 18

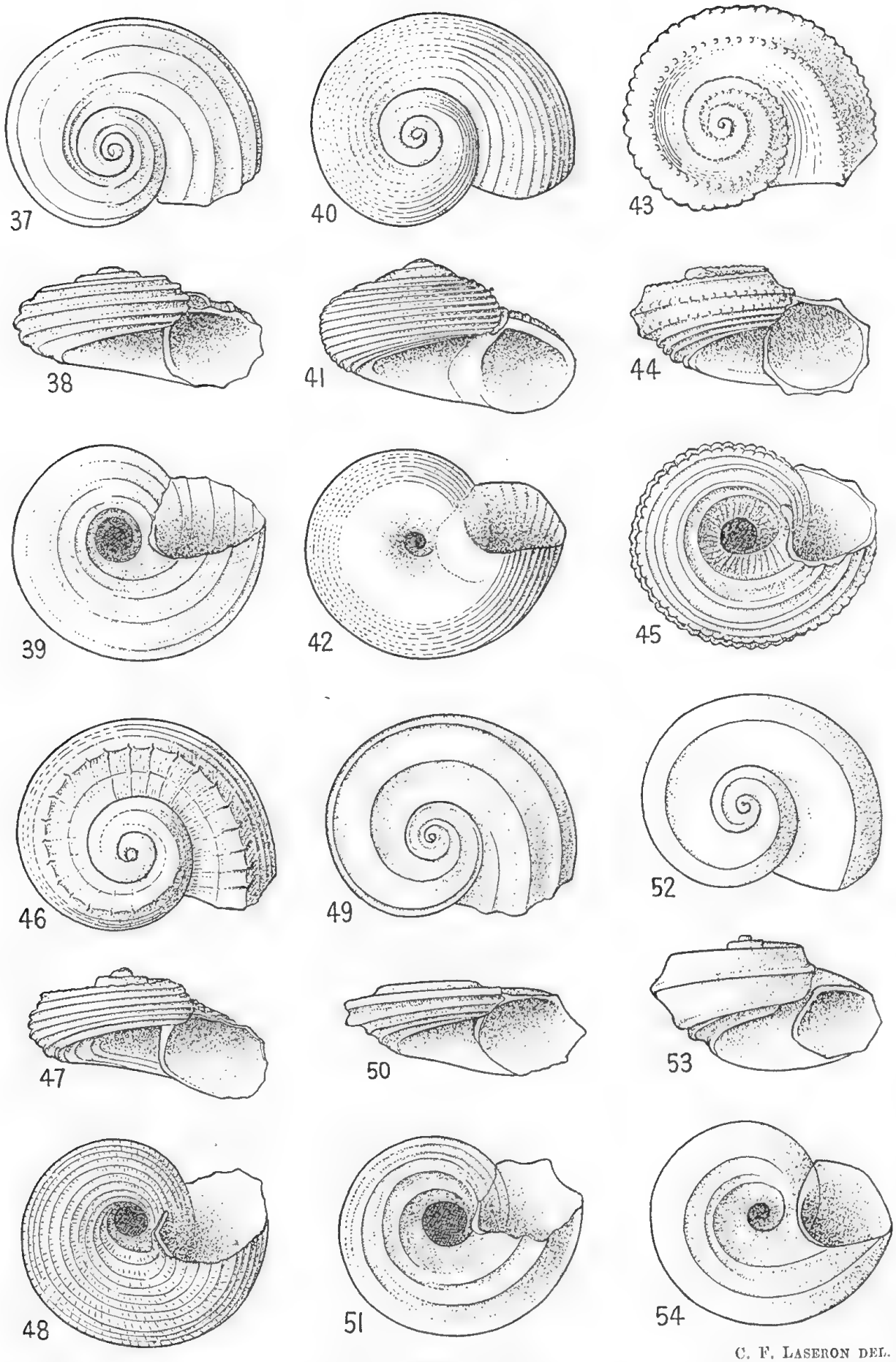
1-3, *Liochrysta acidula* (Melvill and Standen); 4-6, *Austroliotia botanica darwinensis*, subsp. nov., Holotype; 7-9, *Pseudoliotia yowllandi* (Brazier); 10-12, *Pseudoliotia tropica*, sp. nov. Holotype; 13-15, *Pseudoliotia arialis*, sp. nov. Holotype; 16-18, *Pseudoliotia liliputia*, sp. nov. Holotype.



C. F. Laseron del.

FIGURES 19 TO 36

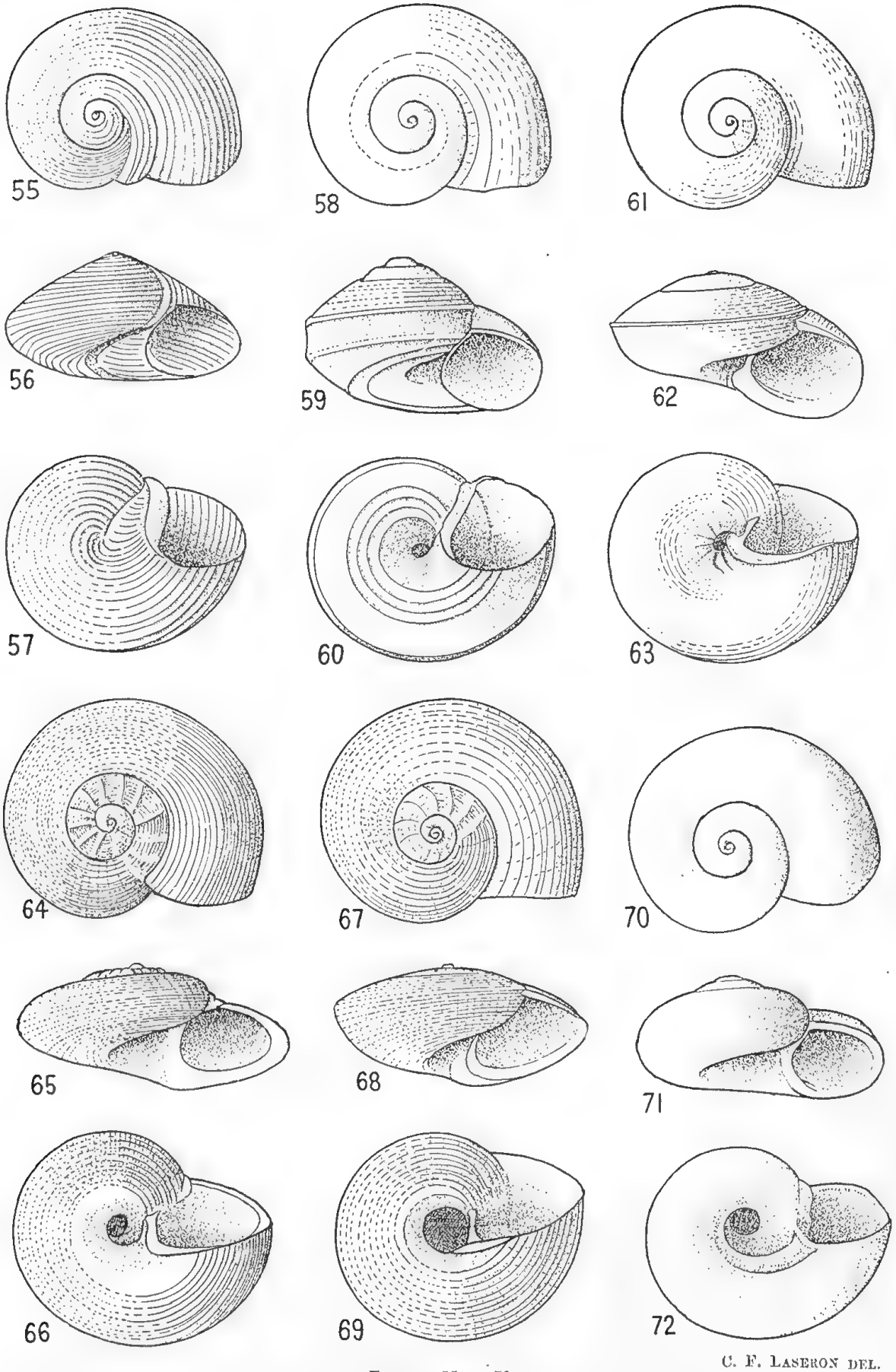
19-21, *Discreliotia radians*, sp. nov. Holotype; 22-24, *Discreliotia serrata*, sp. nov. Holotype; 25-27, *Lioprora rostrata* (Hedley); 28-30, *Circumstella devexa* (Hedley); 31-33, *Liotella eleyans*, sp. nov. Holotype; 34-36, *Liotropica introspecta* (Hedley).



C. F. Laseron del.

FIGURES 37 TO 54

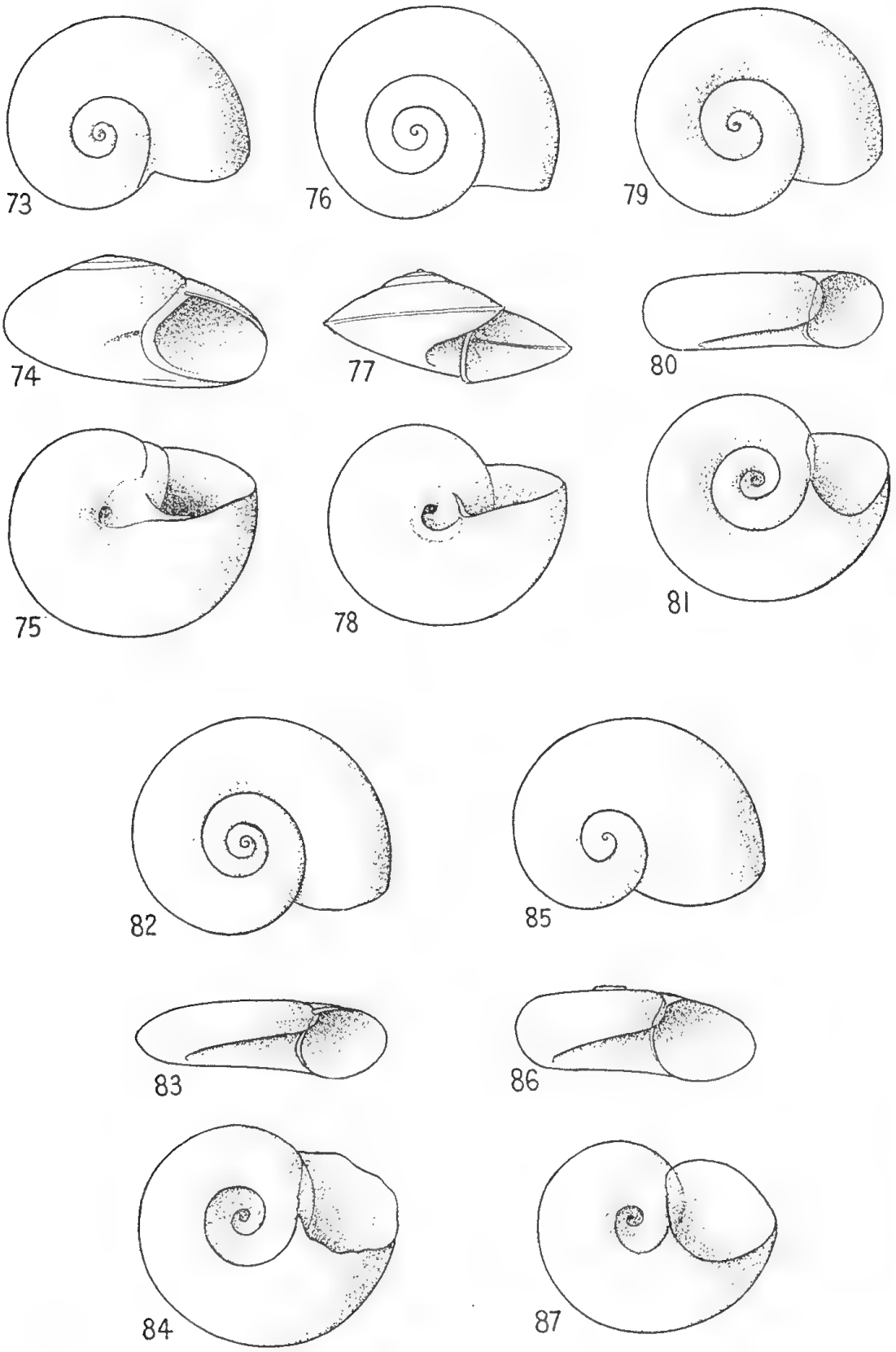
37-39, *Circlotoma rotata*, sp. nov. Holotype; 40-42, *Circlotoma callusa*, sp. nov. Holotype; 43-45, *Circlotoma venusta* (Hedley); 46-48, *Circlotoma transculpta*, sp. nov. Holotype; 49-51, *Circlotoma planorbis*, sp. nov. Holotype; 52-54, *Moeniatoma diamura*, sp. nov. Holotype.



C. F. Laseron del.

FIGURES 55 TO 72

55-57, *Callodix conica*, sp. nov. Holotype; 58-60, *Tholostoma carinata*, sp. nov. Holotype; 61-63, *Caperella orbitum* (Hedley)?; 64-66, *Caperella orbitum*, another specimen; 67-69, *Caperella umbilicata*, sp. nov. Holotype; 70-72, *Peripitoma vitrea*, sp. nov. Holotype.



C. F. Laseron del.

FIGURES 73 TO 87

73-75, *Rotostoma impleta*, sp. nov. Holotype; 76-78, *Circulter acuta*, sp. nov Holotype; 79-81, *Microdiscula involuta*, sp. nov. Holotype; 82-84, *Microdiscula planorbis*, sp. nov. Holotype; 85-87, *Microdiscula augmenta*, sp. nov. Holotype.

Sydney: V. C. N. Blight, Acting Government Printer—1958

A KEY TO THE AUSTRALIAN FAMILIES OF ACALYPTRATE DIPTERA (INSECTA)

By David K. McAlpine
(Figs. 1–5). Manuscript Received 23. 1. 58.

SYNOPSIS

An artificial key to all the families of the superfamily Acalyptrata believed to occur in Australia and one other Australian family of similar facies is presented. Notes on the setting out of the key and some of the important characters used are included. The superfamily Acalyptrata is briefly defined and the family location of certain genera is emended. A list of families with the more important synonyms is provided.

INTRODUCTION

Australian entomologists wishing to make identifications of Diptera have experienced great difficulty in allocating material to the families of the superfamily Acalyptrata and it has frequently been stated that no satisfactory key to the Australian families exists. Two important keys to the dipterous families of the world have been in common use in recent years, one in German by Hendel (1938), and one in English by Brues and Melander (1932), revised by Brues, Melander and Carpenter (1954). These keys are of great assistance but some of the characters used, most notably the number of breaks in the costa, are much too variable to warrant the importance attributed to them. Moreover these authors were not very familiar with the Australian fauna and many of the characters useful in placing Holarctic forms do not apply to Australian representatives of the same families.

The author has attempted to make the present key as comprehensive as possible. He has examined the descriptions and all available material of the more aberrant genera recorded from Australia and much material of unrecorded forms. The arrangement used in the key has not been arrived at quickly. The scheme has been altered many times and prolonged consideration has been given to certain points. It is now considered likely that only some of the more unusual forms as yet unknown to the author will fail to run to the correct family. However, it should be remembered that the Acalyptrata of the western half of the Australian continent are almost unknown, whilst there are probably some aberrant forms still to be discovered in the east.

The characters here used are frequently not available for distinguishing non-Australian forms. It has been found impracticable to attempt a phylogenetic arrangement. The characters which provide evidence for relationship between families are frequently too inconstant for use in the key.

Certain families have been stated to occur in Australia, but their presence must be considered doubtful as no species are recorded and no material is available. The family Cordyluridae, though once placed in the Acalyptrata, is now accepted as belonging to the Calyptrata. To avoid confusion it has been included in the key. The family Conopidae has been variously placed in the Acalyptrata, Syrphoidea, or in a superfamily to itself, the Conopoidea. Recent investigations suggest that the family is best placed in the Acalyptrata. The family Braulidae, which has been referred to the Pupipara and to the Phoroidea, is included in the Acalyptrata by some recent authors (*e.g.*, Hennig, 1938). The latter course is here followed.

Where there may be some doubt as to the reason for accepting a family as Australian or as to why a family is placed at a certain position in the key, the names of all Australian genera running to this point in the key are placed in brackets before the family name.

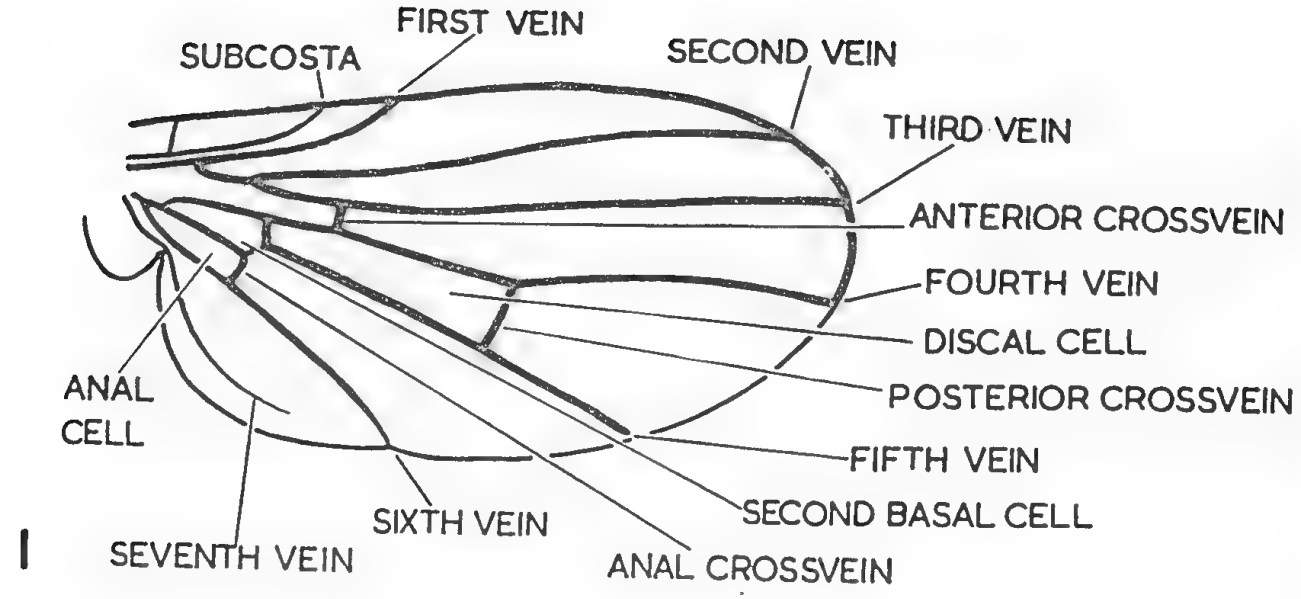
NOTES ON SOME CHARACTERS USED IN THE KEY

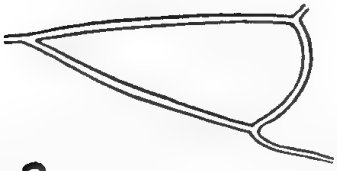
Wing Venation.—There is still so much disagreement concerning the homologies of the veins in the Diptera that it seems best to adhere to an old, but not disused, system of numbering the veins from front rear. Only the subcosta (auxiliary vein of many authors) is here referred to by a name indicating its homologies in other groups.

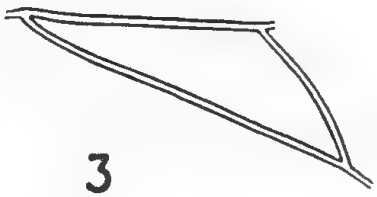
In addition to the longitudinal veins there are three principal transverse veins, usually inaccurately called crossveins. These are the inner or anterior crossvein, the posterior or discal crossvein, and the anal crossvein.

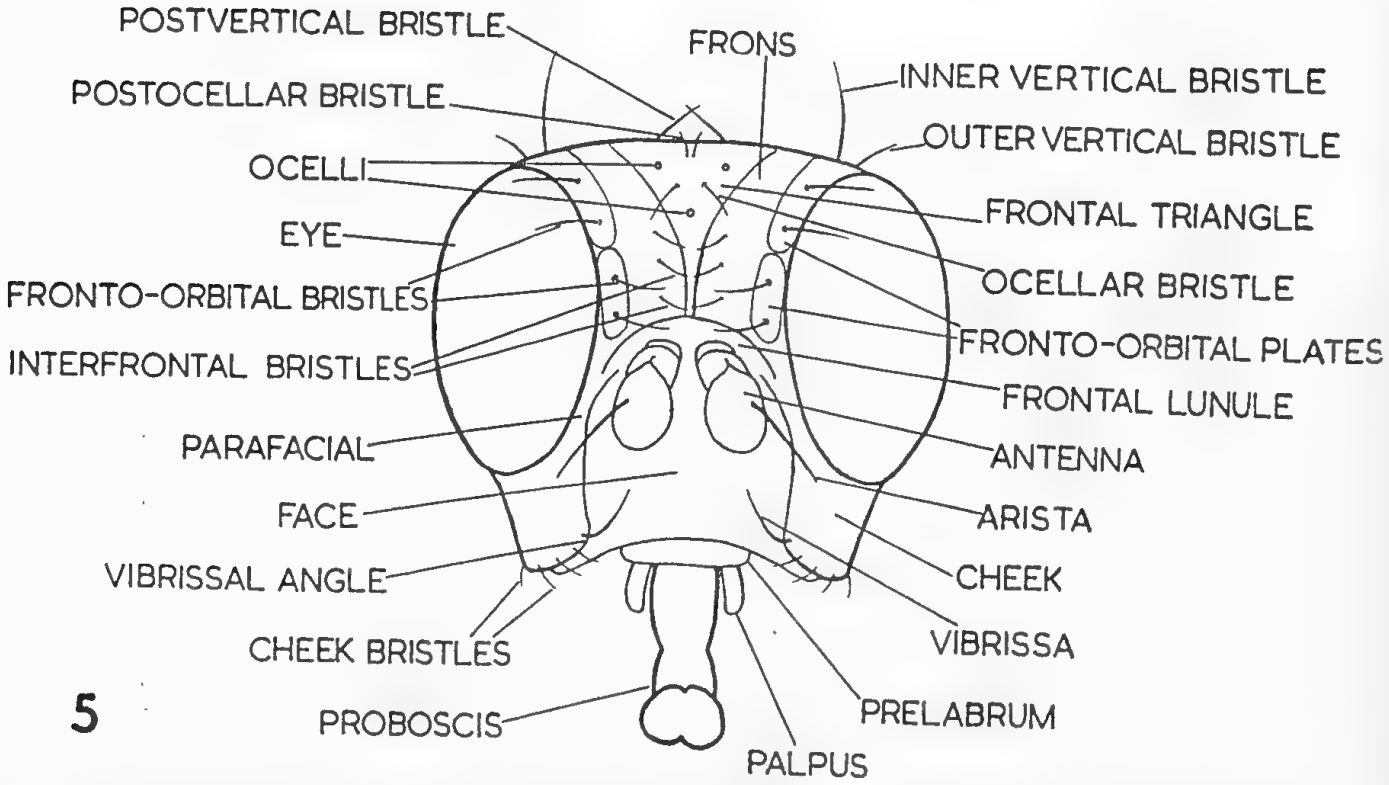
The principal cells of the wing used in classification are the discal, anal and second basal cells. The form of the anal cell is an important character (see Figs. 2 to 4). Fig. 1 illustrates the terminology of the veins and cells used in the key.

Chaetotaxy.—Chaetotaxy refers to the arrangement and number of the cuticular bristles. For the purposes of description a bristle is defined as a hair of outstanding length and thickness. The smaller thickened hairs are termed setulae. The distinction between bristles and setulae is only one of degree but is a most convenient one. It is not considered necessary to describe or illustrate the thoracic chaetotaxy of muscoid Diptera as satisfactory accounts and diagrams appear in most textbooks of systematic entomology (*e.g.*, Tillyard, 1926, Fig. W12). The chaetotaxy of the head is less frequently fully described and is therefore illustrated in Fig. 5.









FIGS. 1 TO 5.

Diagrams of Acalyptrate structure to illustrate terminology. 1, Wing. 2, Anal cell in which the anal crossvein is recurved. 3, Anal cell of the type occurring in Conopidae. 4, Anal cell which is acutely produced through the angulation of the anal crossvein. 5, Anterior aspect of head.

SUPERFAMILY ACALYPTRATA

Diagnostic Description

Cyclorrhaphous Diptera having three antennal segments, the distal one usually bearing a hair-like arista on its dorsal surface. Second antennal segment with dorsal longitudinal suture, when present, almost invariably not reaching to base. Ptilinal suture present. Posthumeral bristles (as distinct from presutural bristles) not developed. Transverse suture of mesoscutum usually interrupted in middle. Inner squame of wing base usually vestigial.

NOTES ON THE FAMILY LOCATION OF SOME GENERA

The systematic position of the following Australian genera requires clarification.

Fergusonina Malloch has been placed in the Agromyzidae. Frick (1952) states that it does not belong to that family but does not suggest any other family to which it might be related. Tonnoir (1937), presented evidence suggesting that *Fergusonina* belongs to a distinct family but set up for it a new subfamily, Fergusoninae, of the Agromyzidae. As there seems more evidence for relationship to the Agromyzidae than to any other family Tonnoir's course is tentatively accepted. The name of the subfamily is emended to Fergusonininae in accordance with the International Rules of Zoological Nomenclature.

Waterhouseia Malloch (1936) was originally tentatively placed in the family Anthomyzidae. The differences from all other genera of the family are so great that this position seems inappropriate. I have carefully examined the type of *W. cyclops* Malloch, the only known specimen representing the genus, but have been unable to find evidence for close relationship to any known family. Until more specimens are obtained we can only accept the slender evidence presented by Malloch for its allocation to the Anthomyzidae.

Aphaniosoma was recorded from Australia by Malloch (1925) as a geomyzid but the genus is generally placed in the Chiromyiidae being closely related to *Chiromyia*.

The genus *Minda* Paramonov (1957) was considered to represent a new monotypic family, Mindidae. *Minda* is synonymous with *Pemphigonotus* Lamb (1917) **(syn. nov.)** as its type species, *M. rubra* Paramonov is very similar to *P. mirabilis* Lamb, the type of *Pemphigonotus*, though it may be specifically distinct. Paramonov's specific name is preoccupied by *Chlorops rubra* de Meijere (1910) which has been transferred to *Pemphigonotus* by Sabrosky (1940). The representatives of this genus had always been referred to the Chloropidae prior to Paramonov's recent work.

Through the courtesy of Dr. Paramonov and Mr. F. A. Perkins, the author has been able to examine specimens in the collection of the C.S.I.R.O. Division of Entomology and the Entomology Department, University of Queensland, and is now fully convinced that *Pemphigonotus* is only a slightly atypical chloropid. In support of this conviction the following notes are offered.

Of the characters mentioned by Paramonov " which separate this genus from all other Acalyptrate families and genera ", all are found in the Chloropidae. Three other characters are most unusual for the Chloropidae. I have not met with any other chloropid with the costa unbroken but this character is known to vary in some other acalyptrate families. The very oblique posterior (discal) crossvein is also an unusual character for the Chloropidae. The costal cell (external subcostal cell of Paramonov) is slightly longer than in other Chloropidae but is not, as Paramonov supposed, longer than in most Periscelididae.

The postvertical bristles are present and convergent as in most Chloropidae, though very small, in *Pemphigonotus* contrary to Paramonov's statement, " entirely lacking bristles on the whole body". The notopleural, prescutellar dorsocentral and scutellar bristles are scarcely differentiated from the surrounding hairs in some other Chloropidae (e.g., *Batrachomyia atricornis* Malloch). The whole subfamily Chloropinae of the Chloropidae has the subcosta scarcely extending beyond the apex of the third vein (R_5), exactly as in *Pemphigonotus*. There is at least one other carrion-feeding species in the Chloropidae, *Prohippelates nigricornis* (Thomson), which breeds in stranded marine molluscs. The structure of the epistome in *Pemphigonotus*, as described by Paramonov, is the same as that in many genera of Chloropidae but quite distinct from that of other Acalyptrata. The depressed elongate pollinose area on the dorsal surface of the hind tibia is another character occurring only in certain Chloropidae. A further important character of *Pemphigonotus* which has been overlooked is the strongly developed vertical carina on the propleuron, which is confined to, and is quite constant in, the Chloropidae among the Acalyptrata.

In view of the fact that its type genus is a chloropid the family Mindidae must be sunk as a synonym of Chloropidae **(syn. nov.)**.

The author agrees with Sturtevant (1954) and Hennig (1956) in placing *Stenomicra* in the Anthomyzidae rather than the Asteiidae or Periscelididae. He is doubtful if the transference of *Cyamops* from the Periscelididae to the Anthomyzidae proposed by Sturtevant (1954), is justified.

LIST OF FAMILIES INCLUDED IN KEY, WITH MORE IMPORTANT SYNONYMS

Superfamily Calyptrata.

Cordyluridae (Scatophagidae, Scatomyzidae).

Superfamily Acalyptrata.

Conopidae.
Micropezidae (Tylidae, including Calobatidae).
Neriidae.
Pyrgotidae.
Platystomatidae (Platystomidae).
Ulidiidae (including Chaetopsidae).
Trypetidae (Tephritidae, Trypaneidae).
Agromyzidae (including Phytomyzidae).
Lonchaeidae.
Sciomyzidae (Tetanoceridae, including Sepedonidae).
Neottiophilidae.
Rhinotoridae.
Sepsidae.
Piophilidae.
Thyreophoridae.
Psilidae.
Lauxaniidae (Sapromyzidae).
Chamaemyiidae (Ochthiphilidae).
Coelopidae (Phycodromidae).
Helomyzidae (including Trixoscelidae or Trichoscelidae).
Chiromyiidae (Chyromyiidae).
Clusiidae (Heteroneuridae, Clusiodidae).
Anthomyzidae.
Drosophilidae.
Asteiidae (Astiidae).
Periscelididae (Periscelidae).
Canaceidae.
Ephydridae.
Sphaeroceridae (Borboridae, Cypselidae, including Leptoceridae).
Chloropidae (Oscinidae, including Mindidae).
Cryptochaetidae.
Milichiidae (Phyllomyzidae, including Carnidae).
Tethinidae.
Braulidae.

KEY TO AUSTRALIAN FAMILIES OF ACALYPTRATA

1. Wings altogether absent; mesoscutum very short and resembling the abdominal segments; scutellum absent ..... BRAULIDAE
   Functional wings present; mesoscutum large; scutellum present 2

2. Subcosta complete, separate from first vein or meeting it only at apex..... 3
   Subcosta apically indistinct, fused with first vein, or joined to it by sclerotization of the intermediate region 21

3. Occiput broadly flattened so that the head is very closely fitted to the thorax; antennae decumbent, the third segment discoid; tarsi with terminal segment triangular and wider than other segments; principally sea shore species..... COELOPIDAE
   Not as above 4

4. Metathoracic spiracle with one or more fine setulae on lower margin; face with a row of setulae on each side from which the vibrissae are usually not well differentiated; palpi vestigial; ant-like flies with subspheroid head and abdomen constricted basally..... SEPSIDAE
   No setulae on lower margin of metathoracic spiracle; other characters not all as above..... 5

5. One or rarely two pairs of outstanding vibrissae 6
Vibrissae absent or vibrissal angle with a row of undifferentiated setulae 11

6. Vertex excavated; postvertical bristles convergent or absent; preapical tibial bristles vestigial ..... (*Cairnsimyia*) RHINOTORIDAE
Vertex not excavated; postverticals usually present 7

7. Postvertical bristles convergent; preapical dorsal bristles present on at least some tibiae ... 8
Postvertical bristles divergent or absent 9

8. Anal crossvein almost straight; one or two dorsocentrals; femora thickened, with stout ventral spines; costa not spinose ..... (*Tapeigaster*) NEOTTIOPHILIDAE
Anal crossvein recurved; three to five dorsocentrals; at most only the hind femora spinose ventrally; costa often with distinct spines ..... HELOMYZIDAE, part

9. Mesoscutal transverse suture complete; orbital plates continuous with parafacials and bearing incurved lower fronto-orbitals ..... CORDYLURIDAE
Mesoscutal suture interrupted in middle 10

10. Mesopleural bristle present; second antennal segment with a terminal lobe on outer side; face membranous medially with lower margin ill defined; frons at least one quarter the width of head ..... CLUSIIDAE
Mesopleural bristle absent; second antennal segment without terminal lobe; face normally sclerotized; frons of male not over one sixth the width of head (female unknown) (*Waterhouseia*) ANTHOMYZIDAE, part

11. Tibiae with preapical dorsal bristles; first vein not setulose; at most two pairs of fronto-orbitals; no stigmatal bristles on mesopleuron 12
Tibiae without preapical dorsal bristles or, if these are present on middle tibiae, either the first vein is setulose above or the mesopleuron has upper anterior (stigmatal) bristles just behind spiracle 13

12. Sixth vein discontinued well before margin; mesopleural bristle present; postvertical bristles convergent or rarely absent ..... LAUXANIIDAE
Sixth vein discernible almost to margin; mesopleural bristle absent; postvertical bristles usually divergent or parallel ..... SCIOMYZIDAE

13. Anal cell long, acute, with anal crossvein long, oblique and not angulate or indented, or, if the anal cell is shorter with short transverse crossvein (*Stylogaster*), then the proboscis is extremely slender and very much longer than head; third and fourth veins strongly convergent or fused apically; mesopleuron not bristly ..... CONOPIDAE
Anal cell, if long and acute, then with the anal crossvein angulate or indented; proboscis stout, usually shorter than head 14

14. Body very elongate; legs abnormally long; third and fourth veins converging distally; first vein not setulose above 15
Not as above 16

15. Arista dorsal; front legs much shorter than others and widely separated from them MICROPEZIDAE
Arista terminal or almost terminal; front legs at least as long as others, with longer coxae ..... NERIIDAE

16. Incurved lower fronto-orbital bristles present; subcosta abruptly bent forwards to meet costa almost at right angles ..... TRYPETIDAE, part
No incurved lower fronto-orbitals 17

17. Anal crossvein recurved (Fig. 2); first vein not setulose; wings without markings..... 18
Either the anal crossvein angulate so that the anal cell is acutely produced (Fig. 4) or the first vein setulose above; wings usually with dark markings 19

18. Costa broken at end of subcosta; stigmatal bristles present on mesopleuron; postverticals, when present, divergent; third antennal segment elongate, blunt; colour metallic black ..... LONCHAEIDAE
Costa not broken; stigmatal bristles absent; postverticals, when present, usually convergent; third antennal segment rounded or shortly ovate, colour usually dull grey; sometimes shining black ..... CHAMAEMYIIDAE

19. Ovipositor enclosed in a conspicuous, cylindrical or conical, recurved sheath; ocelli usually minute or absent; first vein always setulose ..... PYRGOTIDAE, part
Ovipositor not enclosed in such a sheath; ocelli well developed 20

20. First vein not setulose; third antennal segment quite blunt; third and fourth veins sometimes fused apically; anal cell usually narrowly produced ..... ULIDIIDAE
First vein setulose above; third antennal segment sharpened, or at least somewhat flattened, apically; third and fourth veins not fused apically; anal cell shortly, if at all, produced..... PLATYSTOMATIDAE

21. Hind metatarsus much swollen or shortened and compressed ..... SPHAEROCERIDAE
Hind metatarsus similar to other metatarsi 22

22. Incurved lower fronto-orbital bristles present, but sometimes much shorter than other orbitals and in a separate inner row 23
Incurved lower fronto-orbital bristles absent 27

23. Fold representing distal part of subcosta abruptly bent forward to meet costa almost at right angles; anal cell usually acutely produced; no vibrissae ..... TRYPETIDAE, part
Distal vestige of subcosta close to first vein; anal cell not angularly produced; vibrissae present 24

24. Anal cell absent or open distally; arista plumose; third antennal segment deflexed at an angle to rest of antenna and not wider than second segment.....
(*Stenomicra*, part; undetermined genus) ANTHOMYZIDAE, part
Anal cell closed; arista not plumose; third antennal segment not narrow and deflexed... 25

25. Postvertical bristles divergent; no interfrontals; proboscis and palpi normal AGROMYZIDAE, part
Postvertical bristles convergent or parallel, sometimes a smaller pair of divergent postocellar bristles in front of them; interfrontals usually present 26

26. Lower fronto-orbitals incurved, upper fronto-orbitals not incurved; proboscis usually very long and slender; palpi usually enlarged or spatulate ..... MILICHIIDAE
Fronto-orbitals directed alternately inwards and outwards, the incurved ones sometimes much shorter and in a separate inner row; proboscis and palpi normal; sea-shore species ..... TETHINIDAE

27. Face convex or protuberant; anal cell incomplete; discal and second basal cells confluent; arista often with long hairs above but always none below; antennae usually inserted closer to vertex than to mouth margin; postvertical bristles divergent or absent... EPHYDRIDAE
Not as above 28

28. Anal cell and sixth vein absent 29
Anal cell at least partly enclosed or the sixth vein distinct in part..... 30

29. Postvertical bristles almost always convergent; fourth vein usually slightly bent at outer crossvein and not notably converging with third vein towards apex; propleuron with lateral part flat and separated from the transverse anterior part by a vertical carina ..... CHLOROPIDAE
Postverticals divergent or absent; fourth vein not at all bent at outer crossvein (which may be absent), thereafter gradually curving forward and converging with third vein; propleuron sloping inwards anteriorly, without vertical carina.....ASTEIIDAE, part

30. Antennae very short, lying in deep pits or grooves level with lower margin of eye; fronto-orbitals, when present, directed outwards; frontal lunule highly arched, reaching well above antennae; postvertical bristles divergent or parallel... (*Fergusonina*) AGROMYZIDAE, part
Antennae and frontal lunule not as above 31

31. First vein setulose above; ovipositor enclosed in a conspicuous cylindrical or conical recurved sheath; vibrissae absent; usually large flies, the wings always over 4 mm long ..... PYRGOTIDAE, part
First vein not setulose; no such ovipositor sheath; never large flies..... 32

32. Middle tibia with distinct preapical dorsal bristles; all fronto-orbitals reclinate, or, if one proclinate, then there are two preapical dorsal and one anterior bristle on middle tibia and the antennae are porrect; at least three long dorsocentrals; postverticals convergent; vibrissae present ..... HELOMYZIDAE, part
Tibiae without preapical dorsal bristles, except most Drosophilidae which have a proclinate fronto-orbital, only the one bristle on middle tibia, decumbent antennae and one or two long dorsocentrals 33

33. Subcosta not obsolete apically, either terminating in first vein or joined to it apically by sclerotization of the intermediate region; postverticals more or less divergent..... 34
Subcosta apically obsolescent, free from first vein 36

34. Sixth vein not extending beyond anal cell, the seventh vein often distinct; no true vibrissa though cheek bristles often present; third antennal segment orbicular; sea-shore species ..... CANACEIDAE
Sixth vein extending well beyond anal cell, seventh vein vestigial; one or two pairs of long vibrissae; third antennal segment ovate 35

35. Frons projecting over bases of antennae and bearing anterior marginal bristles; vibrissal angle obsolete; scutellum elongate, at least in male .....
(*Piophilosoma*, *Chaetopiophila*) THYREOPHORIDAE
Frons not projecting, without anterior bristles; vibrissal angle present; scutellum normal ..... PIOPHILIDAE

36. Antenna without arista, third segment very large; head without differentiated bristles ..... CRYPTOCHAETIDAE
Arista present 37

37. One proclinate and one or two reclinate, strong fronto-orbitals; arista usually plumose... 38
No strong proclinate fronto-orbital; arista not usually plumose 39

38. Ocellar, postvertical and outer vertical bristles absent; proclinate fronto-orbital much closer to eye than the single reclinate one; paired facial bristles present .....
(*Cyamops*) PERISCELIDIDAE
The above bristles present, the postverticals usually convergent, occasionally parallel; proclinate fronto-orbital not closer to eye than reclinate ones; typical vibrissae present ..... DROSOPHILIDAE

39. Sternopleural and presutural bristles absent; fronto-orbitals short and weak; no vibrissae... 40
Sternopleural and presutural bristles present; at least one pair of strong, reclinate fronto-orbitals 41

40. Discal, anal and second basal cells open distally; head exceptionally flattened.....
(*Nothoasteia*) ASTEIIDAE, part
All the above cells closed; head not flattened ..... PSILIDAE

41. Three fronto-orbitals; vibrissae not distinctly differentiated from the numerous short facial bristles; mesopleural bristle present; third antennal segment broadly rounded, decumbent ..... (*Aphaniosoma*) CHIROMYIIDAE
One or two fronto-orbitals; vibrissae or a similarly situated pair of bristles present; mesopleural bristle usually absent; third antennal segment narrow and decumbent or broadly rounded and porrect..... (*Stenomicra*, part, *Teratomyza*, etc.) ANTHOMYZIDAE, part

ACKNOWLEDGMENTS

Thanks are due to Dr. J. W. Evans, Mr. A. Musgrave, Dr. A. R. Woodhill, Mr. G. H. Hardy and Dr. S. J. Paramonov for giving helpful advice in the preparation of this paper; also Mr. D. J. Lee, of the School of Public Health and Tropical Medicine, University of Sydney, and Mr. F. A. Perkins of the Entomology Department, University of Queensland, who have made available for study the material in the collections of their departments. In addition, Mr. Hardy has collected much material to aid the author's studies. The author also expresses his sincere thanks to Miss P. Goodwin for her careful typing of the manuscript.

REFERENCES

Brues T. C. and Melander, A. L. 1932. Classification of Insects. *Bull. Mus. comp. Zool. Harv.*, Cambridge, Mass., 73. 672 pp.

Brues, T. C., Melander, A. L. and Carpenter, F. M. 1954. Classification of Insects. Revised ed. ibid., 108, 917 pp.

Frick, K. E. 1952. A Generic Revision of the Family Agromyzidae (Diptera) with a Catalogue of the New World Species. *Univ. Calif. Publ. Ent.*, Berkeley, 8 : 339–452.

Hendel, F. and Beier, M. 1936. Ordnung der Pterygogenea : Diptera = Fliegen. In Kükenthal, *Handb. Zool., Berl.*, 4, Heft 2 : 1730–1998.

Hennig, W. 1956. Neue neotropische Acalyptrata aus dem Deutschen Entomologischen Institut (Diptera : Acalyptrata.) *Beitr. Ent.*, Berlin, 6 : 146–154.

Lamb, C. G. 1917. Notes on Exotic Chloropidae. *Ann. Mag. nat. Hist.*, London, (8) 19 : 33–58.

Malloch, J. R. 1925. Notes on Australian Diptera. VI. *Proc. Linn. Soc. N.S.W.*, Sydney, 50 : 80–97.

———— 1931. Exotic Muscaridae (Diptera). XXXIII. *Ann. Mag. nat. Hist.*, London, (10) 7 : 473–492.

———— 1936. Notes on Australian Diptera. XXXVI. *Proc. Linn. Soc. N.S.W.*, Sydney, 61 : 259–261.

Paramonov, S. J. 1957. Notes on Australian Diptera (XXI). Mindidae—a New Family of Acalyptrata (Diptera). *Ann. Mag. nat. Hist.*, London, (12) 9 : 779–783.

Sabrosky, C. W. 1940. Chloropidae (Diptera) of the Oriental Region. *Ann. Mag. nat. Hist.*, London, (11) 6 : 418–427.

Sturtevant, A. H. 1954. Nearctic Flies of the Family Periscelidae (Diptera) and Certain Anthomyzidae Referred to the Family. *Proc. U.S. nat. Mus.*, Washington, 103 : 551–561.

Tillyard, R. J. 1926. Insects of Australia and New Zealand, 560 pp., Angus and Robertson, Sydney.

Tonnoir, A. L. 1937. Revision of the Genus *Fergusonina* Mall. (Diptera, Agromyzidae). *Proc. Linn. Soc. N.S.W.*, Sydney, 62 : 126–146.

Sydney: A. H. Pettifer, Government Printer—1958.

CAVE ART OF THE CONJOLA DISTRICT

New South Wales

by

FREDERICK D. McCARTHY

(Plate 22. Figures 1–5)

(Manuscript received 28–3–58)

Three of the five sets of aboriginal drawings described in this paper were discovered in the early 1880's by Messrs. A. Cork and F. White, local residents, but the latter, and Mr. A. Milne, failed to find them just before 1900 in the heavily forested sandstone ranges in which they are situated. They were, however, re-located a few years later by Captain J. Cork, Inspector A. Milne, and Mr. J. Higgins, and this enabled Robert Etheridge, jun., then Director of the Australian Museum, to visit the site and publish (1904) a brief but somewhat inaccurate description of the drawings. His description, however, indicated that the drawings were of unusual importance among eastern New South Wales pictographs, and several years ago inquiries about their situation were again instituted. Etheridge did not include a map and his written directions were too vague to be a guide. Mr. H. C. Claydon had visited these shelters in 1938 and had sent to the Museum a series of six tracings of various figures. He was able to find the shelters again early in 1957, but two local residents—interested in the matter by Mr. D. Hasell—Messrs. G. Turnbull and C. Woods, in searching for them found two additional sets of drawings several miles away on Bunnair Creek. I am grateful to these four men for their interest and help in this task, and particularly to Mr. Turnbull, who acted as guide and assisted me with excavation work during a week spent in the area in November, 1957. I was accompanied by Mr. John Beeman, artist at the Australian Museum, who made the actual recordings, but much consultation was necessary between us to elucidate many of the figures owing to their age and the weathering of the rock surfaces.

A special frame has been devised by Mr. Beeman for recording cave drawings. It consists of a 6-in. string grid attached to a flexible 3-ply frame. Adjustable legs are attached at each end and two other supports are used when necessary. This grid can be pressed into the curve of a ceiling or wall, and moved along a datum line to cover the whole area of drawings.

FLAT IRON CREEK SITES

Flat Iron Creek flows eastward for several miles from the ranges into a marsh near the main Prince's Highway. A timber track runs into the site, a distance of 4½ m west of the main road, the military map reading being 512385. Three of the shelters are situated on one of the tributaries at the head of this creek.

Cave 1 (Figs. 1 & 2)

The main or biggest shelter is located on the western bank of the creek, at the base of a high ridge. The shelter runs from north-west to south-east, facing the north-west, and the sun does not enter it, so that it forms a cool retreat in summer but a cold one in winter. It is 140 ft long, being wide and high from the middle to the northern end ; from the middle to the southern end the ceiling is only a few feet from the floor, and the back wall a few feet from the front ledge. The cave is 20 ft at the widest part, with a floor 16 ft wide. The ceiling is from 7 to 8 ft high for between 10 and 12 ft from the back wall, then slopes upwards at its front edge. The floor is a slightly sloping bench of sandstone on which an ashy soil deposit up to 1 ft thick is spread over the middle and northern end. Water levels on the rocks indicate that in periods of heavy rain the creek rises almost to the floor level, which is only a few feet above the creek bed.

In this shelter the surfaces suitable for drawings are not very good and the paintings are widely distributed. The ceiling is of hard coarse red sandstone, with inclusions, and has not been used for drawings; these are on various surfaces of a finer-grained creamy bed of sandstone. In this locality the coarse sandstone grades down through finer grades to a hard quartzite-like variety.

In Section II the rock has weathered in such a way that the surface has formed a thin hard crust, portions of which, bearing parts of drawings, have fallen away or disintegrated into sand. In other places thicker pieces have weathered out of the wall. Not all of this weathering took place since the aboriginal artists worked in the cave. There is, for example, a particularly well preserved little stick-man drawn across one white patch from which the surface has weathered away.

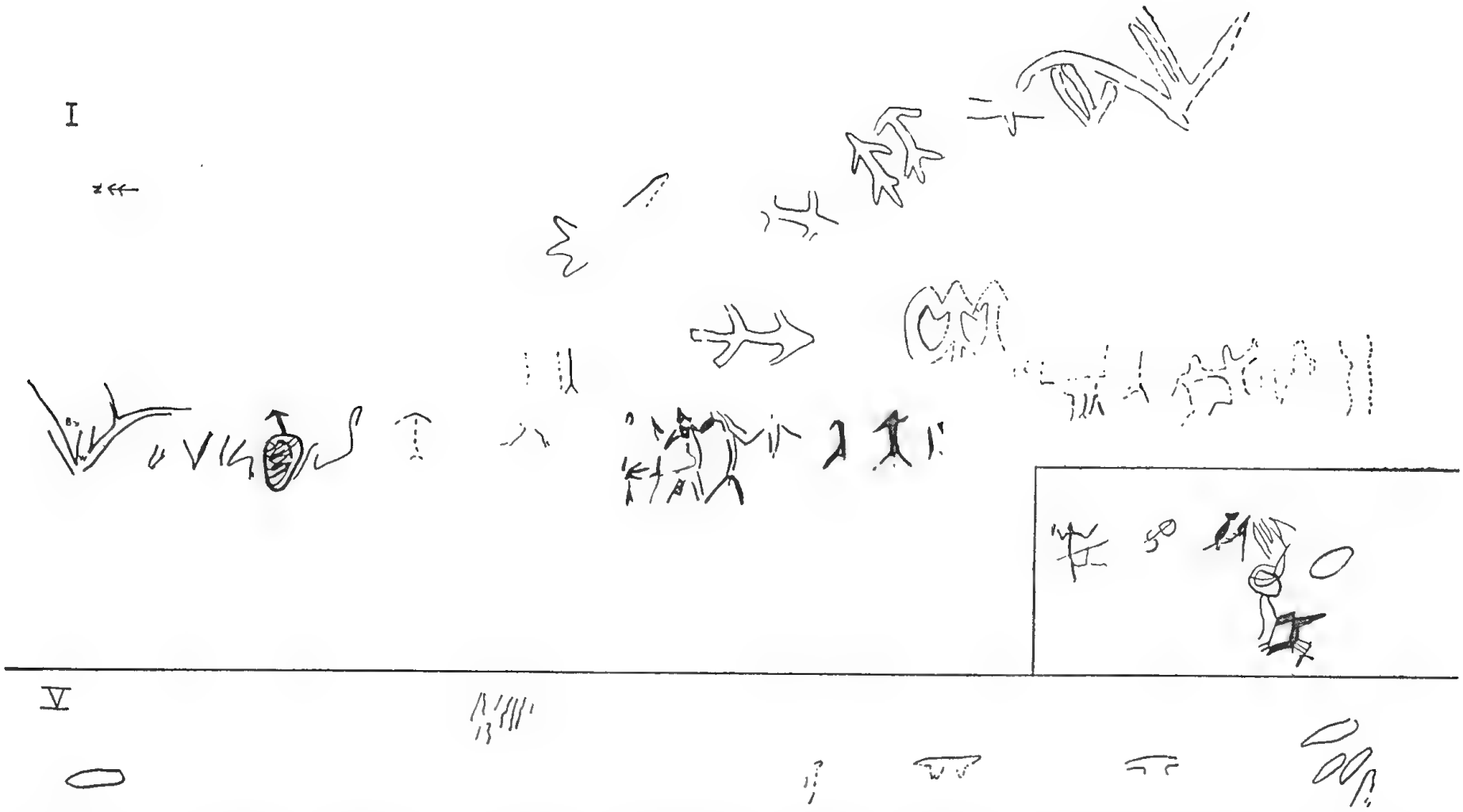


Fig. 1—Flat Iron Creek, Cave 1. Section I is at the northern end of the shelter. In situ, the figures inset (lower right) are a continuation of the series directly above them.

The drawings in Cave 1 have been divided into five sections, as follows :—

I. On the flattish wall of a concave hollow 15 ft wide at the northern end of the cave. (Fig. 1).

II. A similar concave hollow adjoining the southern end of Section 1. (Fig. 2).

III. On a vertical and flat surface, up to 2 ft deep, running along the middle of the ceiling, in the middle of the cave, facing the opening. (Fig. 2).

IV-V. Scattered along the back wall of the southern portion of the wide part of the cave. (Figs. 1 and 2).

A study of the superimpositions revealed that four distinct periods of art followed one another in this shelter, and I have termed them the Stencil, Red, Black and Bichrome Periods. The drawings will be described in these groups.

Stencil Period

There are five white human hand stencils in Section II, most of them showing only the fingers, and only one hand is well preserved. The spraying technique with which they were done is clearly evident.

Red Period

The seven red figures are done in a rich red ochre, ample supplies of which are available in the creek debris in the form of small water-worn pebbles derived from a band in the sandstones. It is somewhat surprising, therefore, that so few figures are drawn in this colour. The red figures consist of three little men, lacking legs; three faded and indeterminate figures (two of which may be little men); and one larger figure, 15 in long, which appears to be a goanna or other lizard. One of the little men is at the southern end of Section I, but the others are in Section II. They are all silhouettes drawn with dry pigment rubbed thickly lengthwise up and/or down the body and arms, usually not in a transverse or round-and-round way.

Black Period

There are 68 figures drawn with charcoal, comprising—

	Outline	Linear	Silhouette	Outline with line design	Totals
Men	2	...	7	...	9
Stick-men	...	9	...	...	9
Wallaby-kangaroos	...	...	3	...	3
Mammal	...	...	1	...	1
Mammal or bird	...	...	1	...	1
Mammal skin	1	...	...	...	1
Ovals	12	...	...	...	12
Parallel lines	3 prs.	...	...	...	3 prs.
Lines	...	4	1	...	5
Indeterminate	13	7	3	1	24
	31	20	16	1	68

Outlines—Figures of unusual interst in this group include a branching design (top right) in Section II; the skin, 1 ft 9 in long, of a dead wallaby or possum in Section III (middle top); and the branching design which resembles those from the lower Murray River shelters (Sheard, 1928), in Section IV. The meaning of the ovals is not known.

Linear—The dainty little stick-men, of which there is one in Section I, six in Section II, and three in Section III, are all depicted from the front with horizontal or upraised arms, but with no weapons. One in Section I has almost horizontally disposed legs. Other examples of this style include a V-shape and irregular lines.

Silhouettes—The little men in corroboree posture are typical of the cave art of eastern New South Wales, and several characteristic examples of them are shown in Sections I and II. At the southern end (middle of inset, Fig. 1) of Section I is a tiny figure which represents either a jerboa or a bird. In the lower middle of Section II are three wallabies or kangaroos, all in upright poses but not leaping as they are so often shown in aboriginal cave art.

Fig. 2—Flat Iron Creek, Cave 1. Section II joins up with the southern end of Section I in Fig. 1. Section III is on several vertical ledges in the ceiling in front of Section II. Section IV is in an alcove between Sections III and V.

Outline with interior line design—At the northern end of Section I is a figure, 11 in high, with an oval body in which a curvilinear design has been drawn; from its top is an arrow-shaped projection. Its meaning is unknown.

Remarks—The figures of this "black period" are well within the range of this technique elsewhere in eastern New South Wales, both in style and subject, with the exception of the oval figure with an interior line design, in Section I, which is unique. Although the hocker, six men and a lizard are in black outline, they are part of a frieze of bichromes—white outlined with black—and it is probable that the artist intended to add white infilling to them. Should this be true, they really belong to the bichrome period, with which they have been included.

Bichrome Period

This period includes the most interesting series of drawings, of which there are thirty-three in the shelter.

White outlined black—A large number of bichromes are to be seen in Section I. Three of them (top right and lower left) are branching designs, with a crescent, similar to those in the lower Murray River shelters (Sheard, 1928). Four (top middle), and the incomplete figure to the left of them, are intended to be goannas or lizards. Below this series, in the middle of Section I, is an unusual combination of two men, with hands and feet joined in the middle, while the one on the left has a crescentic band connecting his hand and foot. To the right of this figure is another series of up to eight men, most of which are faded and almost indistinguishable.

There is an outstanding portrayal of a man in Section II. He is 2 ft 3 in high, with upraised arms (in unbalanced position), well defined neck, one thick leg and one thin leg (with four toes), a prominent penis, and what appears to be a boomerang or curved club projecting from his side. This weapon is blended with his figure in such a way that the outline of the body is not shown, nor is the rest of the weapon, which cannot be seen behind the body. Below his feet is a dingo not particularly well drawn.

In Section III are the figures of four men (one is reversed) and a wallaby. The series on the left is included here for reasons explained above. They include a hocker man with knees touching elbows, three other men and a lizard.

Red with black outline—There are two figures in this style. At the northern end of Section I occurs an old red oval outlined more recently (during the succeeding black period) with a double black line; it thus represents two periods. At the northern end of Section II is an animal-like figure, 2 ft 9 in long, with a head-like shape at one end; it is incomplete and indeterminate and the red infilling is very faint.

The bichromes comprise 19 men, 1 hocker man, 6 lizards, 3 branching designs, 1 dingo, 1 wallaby, 1 crescent, 1 mammal and 1 oval. Men and lizards (mostly goannas) thus form the main theme of this period.

Superimpositions—1. Red man over white hand stencil; 2. Black stick-man over red silhouette man in two places; 3. Tail of black silhouette wallaby over red silhouette man over white hand stencil; 4. Red and black bichrome over black silhouette figure.

Although there are not many superimpositions, those that occur make it quite clear that the art periods defined herein existed. Nos. 1 and 2 of the superimpositions separate the Stencil and Red Periods, No. 3 supports this distinction, and No. 4 separates the Bichrome Period. No. 3, furthermore, is a key to three of the art periods in this area. The sequence of art periods is important for the reason that in each of the first three a different colour—white, red, black—was used, and in the fourth period these three colours were employed in two combinations; white and black, red and black.

Remarks—Some of the figures in this shelter form compositions. Thus in Section I there are several lines of dancing men; in Section II the bichrome man and dingo form a pair, as do some of the black stick-men; in Section III the lizard and three men in black outline form a group. Otherwise no cohesion or relationship between figures can be perceived.

Cave 2 (Fig. 3)

This shelter is a furlong south-east of Cave 1, and is on the top edge of the ridge forming the eastern bank of the creek, about 130 ft above the creek bed. From it is to be seen a view across, down and up the gorge for a limited distance. This shelter is 30 ft long, 8 ft high and 10 ft deep. The ceiling is a very flat smooth surface of comparatively soft cream sandstone, and in the middle of it a large block has fallen down to produce a stepped area, 8 ft x 6 ft in size, and 2 ft deep. Most of the figures are on the ceiling, a few are on the sides of this hollow, but some are on a vertical face at the southern end of the shelter.

The twenty-nine figures in this shelter (Nos. 10 to 12 are on the back wall) comprise—

1. Upper portion of a little man in white with black outline.
2. Indeterminate, but probably similar to No. 1.
3. Legs of a wallaby or kangaroo, drawn in black outline on a leeched white rock surface. The figure is covered with fine parallel longitudinal lines scratched within the outline. The body has weathered away.

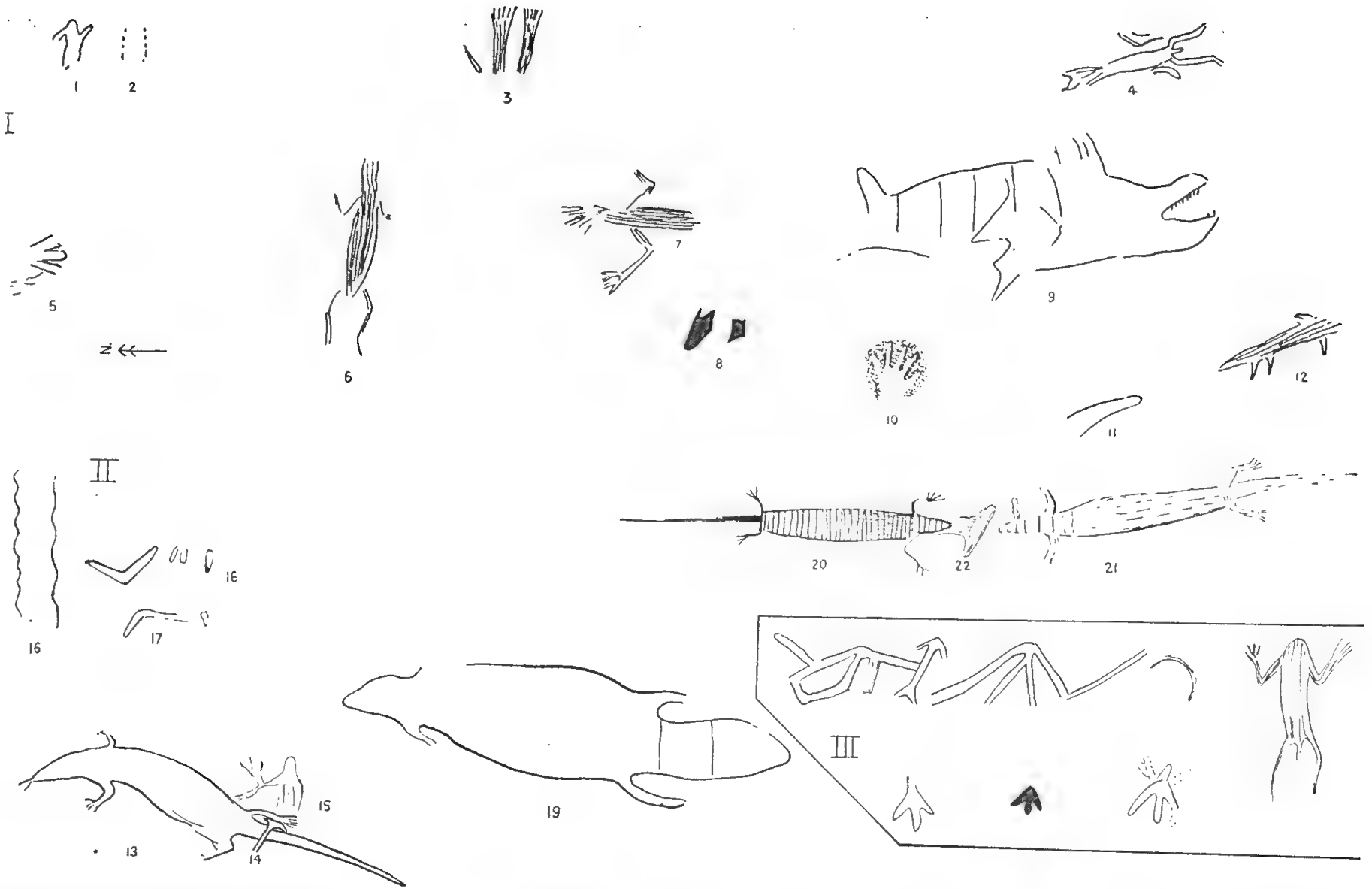


Fig. 3—Flat Iron Creek, Caves 2 and 3. Sections I and II join together to show the figures in the cave as a whole, from north to south. Cave 3 is illustrated in III.

4. A man, with long bent arms upraised, a long slim body and short legs, and a boomerang on each side of his body. He is drawn in black outline.
5. Upper portion of a man scratched in fine lines in the rock.
6. Elegantly portrayed man, 2 ft 1 in high, with arms upraised, and long head, scratched in fine parallel longitudinal lines.
7. Upper portion of a man in black outline and scratched line interior. The fingers are long and well marked, and he is wearing a rayed head-dress.
8. Weathered remnant of small red silhouette figure, indeterminate.
9. A remarkable drawing in black outline, with widely spaced bars across the body, of a seal or whale 4 ft long, showing the tooth-lined open mouth, fin pointing downward, and fish-like tail. On it may be seen the faint outline of a triangular figure.
10. White human hand stencil.
11. Portion of a boomerang in black outline; the interior has been rubbed with another stone.
12. Man scratched in fine lines in the rock.

The balance of the figures are drawn on the ceiling—

13 to 15. A splendid figure of a goanna 4 ft 4 in long, with a long body curved from tail to nose, split tongue, and well marked toes. Its outline is black, but the body has been rubbed with a stone within the outline. There is a club of the phacoid-headed type across the goanna's tail. Above the goanna's leg is posed a man, with arms bent upward, lightly scratched in vertical and parallel longitudinal lines. It is impossible to decide if there is any super imposition here but the three figures probably form a hunting composition.

16. Two parallel and vertical sinuous black lines over 2 ft long.
17. Two sharply angled returning boomerangs in black outline, 9 in long.
18. Set of four small pointed ovals in black outline.
19. A large and remarkable figure, almost 5 ft long, of a gecko lizard, with two bars across the huge tail, in black outline. The body has been rubbed with a stone inside the outline. (Alive, these lizards are 4 to 6 in long).

20 to 21. Two barred black outline lizards, probably goannas, 3 ft 7 in and 4 ft long, facing one another on the top of the flat wall of the shelter. They have well marked digits on the limbs which, like the tail, are in solid colour. Portion of the rock surface is covered with a white leaching, and No. 20 is drawn on this surface. No. 21 is faded and faintly discernible, being drawn in a comparatively exposed position. Its limbs and digits are shown with fine scratched lines.

22. Two old white striped indeterminate figures.

Styles—

Stencil, No. 10.

Black outline, Nos. 4, 16, 17, 18.

Black outline, barred, No. 20.

Black outline, with rubbed interior and barred end, No. 9.

Black outline, with rubbed interior, Nos. 11, 13, 19.

Black outline, with scratched line interior, Nos. 3, 7, 23.

White with black outline, Nos. 1, 2.

Red silhouette, No. 8.

Scratched longitudinal lines, Nos. 5, 6, 12.

White stripes, No. 22.

Superimpositions—Barred outline and rubbed goannas over white striped figures. The superimpositions are too few to throw any light on the art periods in this shelter, but it is obvious that the figures with rubbed and scratched interiors, or those scratched into the soft rock, belong to the later period.

Remarks—The seal and gecko are rare subjects in Australian cave art, that of the seal being unique. The goannas (Nos. 13, 20) and little men (Nos. 6, 7) are particularly well drawn, and the gecko displays an unmistakable walking motion.

The previously unrecorded techniques for Australia of using the fine parallel longitudinal scratched lines, both separately and within a black outline, and of rubbing the whole of the surface within a black outline with an abrading stone, are represented in some of the other shelters.

The goanna in No. 20, with barred body design combined with solid limbs and tail, is drawn in a style common on Groote and Chasm Islands (McCarthy, 1955).

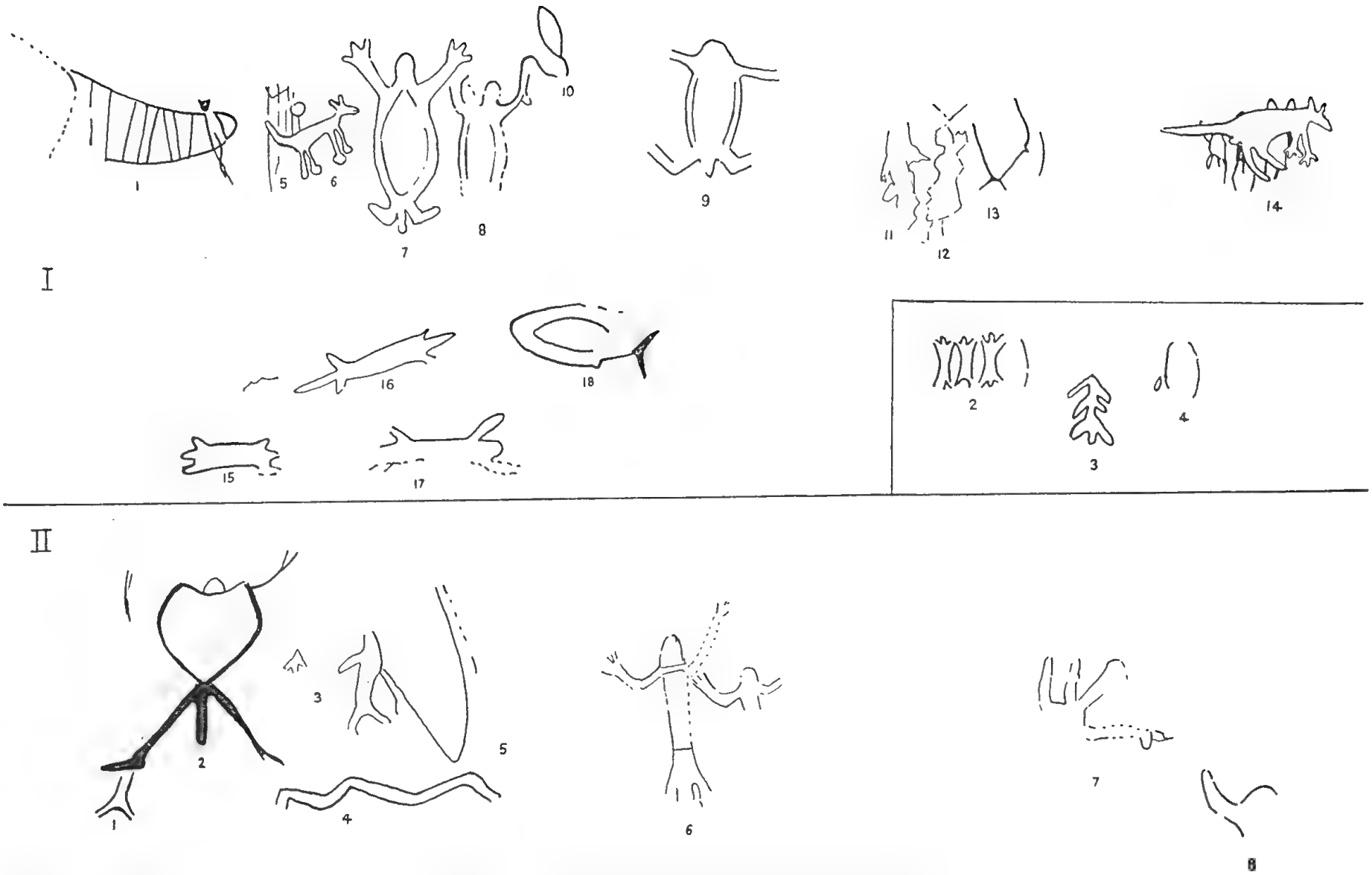


Fig. 4—Bunnair Creek Caves. I, Cave 4; II, Cave 5. For the purposes of illustration, paintings numbered 2 to 4 in Section I are shown separately; on the cave wall they occur below No. 1 of this Section.

Cave 3 (Fig. 3, inset)

This shelter is similar in conformation, size and situation to Cave 2, and is about a furlong further southward along the top edge of the ridge, on the next knoll. The ceiling is rough, and the drawings are on two flat faces of the back wall, other suitable ledges not being used.

On the top ledge is a series of four figures comprising a geometric shape, a little short-limbed man, and another man, headless, with very long arms, holding long curved objects in his hands, all in white outlined with black. There is a black semi-circle at the end of this series, and on an adjoining vertical surface a beautifully portrayed man, nearly 2 ft high, in very fine red and white stripes. The red appears to have been put on over the white.

On a vertical surface below this series are the upper portions of three little men, one in solid white and one in solid red. The latter appears at first sight to be a bird track but it has a distinct head. The other solid white figure is a six-radiate design which is probably a human figure.

BUNNAIR OR COAL CREEK SITES

There are two shelters containing drawings on the western bank of Bunnair Creek, about 3 m from the Flat Iron Creek sites. A timbergetter's road runs in (past Round Hill) for 4½ m along a ridge till it crosses Bunnair Creek. The caves are about three-quarters of a mile from this crossing. The site is within the area of the unprinted Ulladulla military map and a reading of this kind cannot therefore be given. Both shelters are about 10 ft above the creek bed and face south-west, so that the sun does not enter them at all. They are only a few yards apart.

Cave 4 (Fig. 4, Section I)

This shelter is 30 ft long, with a deep concave hollow 12 ft wide at the southern end, the shelter running from south-east to north-west. It is 15 ft deep and 8 ft high. The ceiling is rough coarse sandstone, and the drawings are done on the back wall from shoulder height almost to the floor. They include two series, black and bichrome.

The twenty-two figures comprise—

1. Portion of a large black outline and barred figure, indeterminate.
2. Three men in black outline.
3. Spearhead or design with a double row of barbs, in white outlined with black.
4. Indeterminate figure in black outline.
5. Faint lines of indeterminate figures in black outline.
6. (Plate 22 bottom). Dingo in black outline with rubbed interior, distinguished by four legs of the same length, with distinct feet or pads, although the head resembles that usually drawn on wallabies and kangaroos.
7. (Plate 22, bottom). Man in black outline bands with rubbed interior. His body is hollow, arms upraised with three fingers on each hand, there is a neck, short legs and a large penis.

8, 9. Similar human figures to No. 4 but very faded and indistinct.

10. Faint lines of indeterminate figures in black outline.

11, 12. Figures (probably of a man and a woman) vaguely defined in black outline.

13. Fish in black outline.

14. (Plate 22, top). Group of four men in black outline, almost covered by a wallaby, nearly 3 ft long, in black outline with rubbed interior. The digits are distinctly shown on the two short forelegs, in contrast to the rounded feet of the dingo in No. 3. The leaping action of this wallaby lacks animation.

15 to 18. Figures, in white with black outline (they have been somewhat damaged by water seeping from a crack above them in rainy weather) of two men (Nos. 15, 17), goanna or other lizard (16), and a fish (18).

Styles—

Black outline: Nos. 2 (three men), 4, 5, 10 (indeterminate), 11, 12 (man and woman), 13 (fish).

Black outline, barred: No. 1 (indeterminate).

Black silhouette: No. 14 (four men).

Black outline with rubbed interior: Nos. 3 (spearhead), 6 (dingo), 7 (man), 8, 9 (faded men), 14 (wallaby).

White with black outline: Nos. 15 (man), 16 (goanna), 17 (man), 18 (fish).

Superimpositions—Black with rubbed interior wallaby over four black silhouette men.

Black with rubbed interior dingo over black outline figures.

The superimpositions reveal two distinct periods, a black, and a bichrome-black with rubbed, or in a few figures white, interior, thus indicating that a similar distinction exists in Cave 1.

Remarks—The most notable feature of this shelter is the series of black and rubbed or white interior figures. The hollow-bodied men are recorded for the first time in south-eastern Australia, there being a large number of them in Napier Broome Bay caves in the northern Kimberleys recorded by G. Hill (Mountford, 1957).

Cave 5 (Fig. 4, Section II)

This shelter is slightly smaller but similar in other respects to the previous one. The limited space available for drawings has been utilised. The shelter is 20 ft long, 8 ft wide, 6 ft high, and faces south-west.

The ten figures comprise—

1. Portion of man in white with black outline.
2. Large human figure, 2 ft 6 in high, in thick black outline, with hollow body. The head is a mere hump on a concave neckline, but the body is massive, the penis large, and the ankle is shown on one foot. It is drawn in a concave area of rock and appears to have been adapted to the area.
3. Man, and portion of another one, in white with black outline.
4. Snake, 2 ft 6 in long, in red with black outline.
5. Curved band in white with black outline.
6. Two men, one wearing a chest ornament and girdle, in black outline.
7. Indeterminate figure, probably human.
8. Indeterminate.

The styles comprise black outline, white with black outline, and red with black outline.

The only superimposition is that of a man in white with black outline over a man in black outline (Nos. 1, 2), thus distinguishing again the black and bichrome periods in the other shelters.

ETHERIDGE'S PAPER

As already mentioned Robert Etheridge, jun., (1904) had described three of the five sets of drawings dealt with in the present paper. Some remarks on his observations are now made, as follows :—

Cave 1

Page 2—Corroboree 26 ft long. There are two series of figures at different levels on the back wall, and many of them are faded and indistinct. They do not form one group but belong to several series.

Pages 2 *to* 3—Emu tracks do not occur in any of these caves. The figures Etheridge mistook for them are the upper portions of little men in red, black or white silhouette. Each one has a distinct head.

Page 3, *Figs.* 9-10—Inaccurately recorded. They represent lizards or men, and the one in Section I of Cave 1 is an unique branching design.

Page 3, *Fig.* 11—A careful examination of this figure in the middle of Section I, revealed it to be two little men with joined hands and feet, while the one on the left has his hand and foot joined by a curved band.

Cave 2—

Pages 5 *to* 6—The " whale " of Etheridge is our seal or whale (Fig. 3, No. 9).

Page 5—The shield of Etheridge is our gecko lizard (Fig. 3, No. 19).

Page 6—The phallic figure is probably our No. 4, a man, or No. 11, half boomerang.

Cave 3—

Page 6—The emu tracks of Etheridge are the upper parts of little men.

Page 4, *Fig.* 13—This is, similarly, a man holding long banded objects in both hands.

General—

Page 6—Comparison with the outline engravings of the Sydney-Hawkesbury area is not supported by our recordings, the styles and subjects varying widely in the two kinds of art.

Part 4—Etheridge said that no figures were done in black splash work alone, nor of the open hand. We found five white human hand stencils done by this method in Section II of Cave 1, and one in Cave 3.

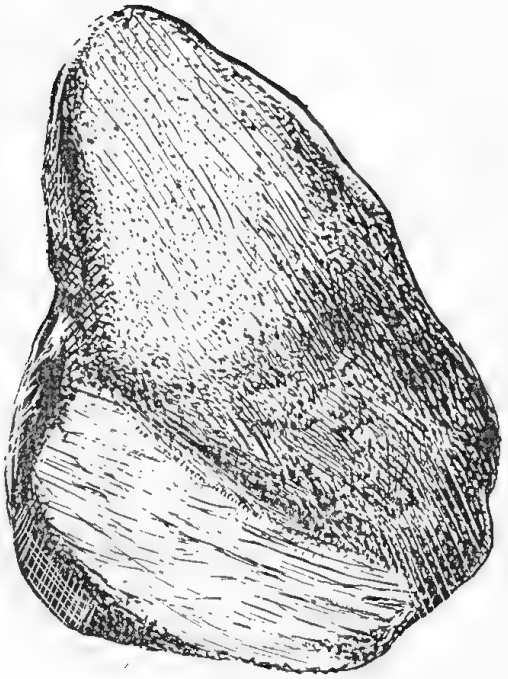


Fig. 5—Abrading stone, believed to have been used for rubbing the interior surface of those figures which had a charcoal outline.

EXCAVATIONS OF CAVE FLOORS

The greater part of the floor of Cave 1 was sieved and it yielded the following implements :—

Abrading Stone (Fig. 5)—A triangular sandstone pebble, 9 x 6 x 4 cm, which has an abraded surface extending across three-quarters of the broad end. It was probably used for rubbing the surface inside the outline of Nos. 9, 11, 13, and 19 in Cave 2, although none was noted as having been rubbed in Cave 1.

Block—A ridged and knapped block of grey chert, oval in shape, 9·5 x 6 x 3·5 cm, heavily worn back by use along one convex lateral margin.

Normal flakes and blades.

Side scrapers — Four narrow blades, 3 to 4·5 cm long, and a flake 3·5 cm long, used as knives and scrapers on one lateral margin. Also a small fragment trimmed on one edge.

Double side scraper — A triangular flake 2 cm long, lightly trimmed on two edges; two narrow blades 3 and 3·75 cm long, trimmed on one edge of one face and on both faces on the other edge. The scrapers are made of jasper and dark grey chert.

Burin — A thick quartzite flake, 3·5 cm long, on which several spalls have been struck from the butt down one lateral margin. The working edge shows distinct use.

Concave scraper — A blade 6 cm long with a narrow concave working edge on one side.

Bipolar fabricators — Three quartz and three chert fabricators, 1·75 to 2·5 cm long, five of which have been well used at both ends and one lightly used at one end.

Bondi point — A point 3 cm long in grey quartzite trimmed right along one edge, and partially at the point end on the other edge of the thick margin. The butt is unworked.

Several pieces of mussel shell, two snake vertebrae, and some small pieces of burnt bone were found.

The deposit consisted of a hard grey soil in the front half of the floor, and a soft ashy-sand in the back half. No stratification was noted. The implements belong to either the Bondaian or Eloueran periods (McCarthy, 1948 : 5-12), and the finding of the *bondi*-point indicates that at least one of the art periods defined is associated with the Bondaian culture. I pointed out (1948 : 28-29) that the Bondaian culture is associated with raw-ochre drawings and stencils in five rock-shelters which have been tested by trenches in eastern New South Wales. The archaeological problem now presents itself of working out the implement assemblages associated with the art periods defined in these and other caves, as observations at various sites indicate quite clearly that a sequence of art periods exists in eastern New South Wales rock shelters but that they vary slightly in different localities. The " stencil period " is the earliest, but further work is necessary before the other periods can be definitely established. The problem is one of outstanding importance, a vital aspect of it being the possibility of ascertaining the period to which the Baiami-Daramulan, the culture-hero art, belongs.

From the floor of the second cave a well trimmed nose-ended scraper 4·5 cm long, on a broad quartzite blade, was trowelled out of loose surface material, together with five unworked flakes. The rest of the floor, as in the third, fourth and fifth, consists of hard earth which yielded no implements.

In Cave 1, in a trough between the edge of the floor and a large rock in situ, is a loose flat boulder of fine grained sandstone on which there are eighteen axe-grinding grooves ranging from some just begun to others 3 cm deep. This boulder appears to have been carried from the creek bed a few yards away and placed in this position by the aborigines. No edge-ground axes were found in the shelters.

References

Etheridge, jun., R. 1904. A Remarkable Rock-shelter in the Milton District. *Rec. Aust. Mus.* 5 : 80-85, figs. 8-13.

McCarthy, F. D. 1948. The Lapstone Creek Cave : Two culture periods revealed in eastern New South Wales. *Rec. Aust. Mus.* 22 : 1-34, pls. i-iv, figs. 1-91.

————————. 1955. Notes on the Cave Paintings of Groote and Chasm Islands. *Mankind* v : 68-76.

————————. 1958. Australiam Aboriginal Rock Art. Australian Museum publication.

Mountford, C. P. 1937. Examples of Aboriginal Art (recorded by G. Hill) from Napier Broome Bay and Parry Harbour, north-western Australia. *Tr. Roy. Soc. S. Aust.* 61 : 30-40, figs. 1-48.

Sheard, H. L. 1928. Aboriginal Rock Paintings seven miles north of Blanchetown, River Murray. *Tr. Roy. Soc. S. Aust.* 52 : 231-34, pl. xxi.

Explanation of Plate 22

Top—

Wallaby in black outline, with rubbed interior, drawn over series of little men in black. (Cave 4.)

Bottom—

Dingo and man in black outline, with white interior. (Cave 4.)

Sydney: V. C. N. Blight, Government Printer—1959

ROCK ENGRAVINGS OF THE SYDNEY–HAWKESBURY DISTRICT

Part 2 : Some Important Ritual Groups in the County of Cumberland

by

FREDERICK D. McCARTHY

(Plates 23–26. Figs. 1–7.)

(Manuscript received 11. 4. 58)

The groups at Mt. Kuring-gai and Maroota, Nos. 1, 4 and 5, comprise some of the outstanding series of rock engravings known in the Sydney-Hawkesbury district, and every effort should be made to protect them from vandalism. The Mt. Kuring-gai group was reported to the Australian Museum over fifty years ago when Etheridge (1904) published a brief description of the principal figures. The Devil's Rock group at Maroota has been known for an equally long time but the other groups described herein were not reported until the last decade.

Mt. KURING-GAI

[Group 1]

Etheridge (1904) did not mention the fish, kangaroo tracks and basket, and his diagram of the anthropomorphic trio is innaccurate. This group is unique in its composition, and a complete re-description and plan of it is necessary for permanent record. It is a remarkable omission from Campbell's 1899 memoir in which other groups in this area are described and illustrated.

The group is situated on the western side of a high ridge, the main one connecting Port Jackson to the Hawkesbury River. The site now lies between the railway and highway to the north, at a spot where they are only thirty yards apart, about half a mile north of the railway station. The ridge is midway between Berowra Creek and Cowan Creek; from it is to be seen a commanding view westward to the valley of Calina Creek into which a number of small tributaries converge to flow into Berowra Waters at Crosslands. To the eastward of the site the ridge rises slightly to block out the view into a gorge leading down into Cowan Creek.

The figures are engraved on a long and narrow ledge of rock which runs north-to-south across the slope of the ridge. They begin with a single human foot track or mundoe on a rock on top of a knoll; 68 ft southward is another rock bearing the next five mundoes, and then 73 ft further on, the next eight occur on separate rock surfaces almost at ground level, running down the slope of the knoll and then up a very slight slope to the end of the main continuous ledge of rock. The main ledge is narrow at its northern end, widens in the middle, and narrows again to a few feet until it joins the main rock surface which is 55 ft x 12 ft in area. A growth of heath in shallow soil projects into the middle of this area. The ledge narrows again at the southern end and on it is engraved a single small mundoe. There are no mundoes on a higher ledge or on lower rock surfaces outside the line of these tracks at the northern end. There is a drop of from 6 to 12 ft to the ground below the main ledge but no occupational deposit is present.

The continuous line of forty-five mundoes runs for a distance of just over a furlong from north to south, and 50 ft further on is the single one mentioned above. The mundoes are mostly from 1 ft 6 in to 7 ft apart; others are from 8 to 15 ft apart. There is a gap of 48 ft between them on an area of rock on the main ledge across which water flows and seeps and on which tracks were either never engraved or have been completely weathered away. There are other gaps of 18, 20, 25, 52, 68 and 73 ft. These mundoes are from two to three times natural size, and are both the longest series and largest individually, yet recorded. Examples of their size (in inches) include 12 x 5, 15 x 10, 19 x 12, 20 x 14, 22 x 6, 22 x 12, 22 x 17, 23 x 7, 23 x 17, 24 x 3, 24 x 14, 27 x 12, 29 x 18, and 30 x 18. They thus correspond in the main to those of the culture hero, whose feet are 25 x 14 in and 22 x 13 in and are intended to represent his tracks, not those of his wives.

The shape of the mundoes is generally oval, some being irregular and others half-ovals. Some are either narrow or broad in relation to their length. The toes indicated vary from two to eleven, six being the commonest number. On two of the mundoes the toes are large round or oval pits, but

otherwise they are shown as short straight grooves. Thirteen of the mundoes bear from one to three punctured dots but on the large pair side by side, which are almost intaglios with the toes inside the outline, there are nine and ten respectively. The twelfth figure from the north in this track is an elongate slug-shaped one, with two antennae, similar to one at Devil's Rock, Maroota (Fig. 6, No. 38).

The last eleven mundoes are on the main rock surface where the track ends abruptly in a large pair, although another very faint one, evidently not re-engraved from time to time as were the others, occurs just beyond them. There is another faded figure, either a mundoe or basket, below the large pair, and a single kangaroo track nearby. This is the longest single line of large mundoes yet recorded, but tracks of human, emu and kangaroo footprints are a feature of rock engravings of the Sydney-Hawkesbury district.

A few feet beyond the end of the mundoe track is the main set of figures. It comprises a huge culture hero, his two wives and some small fish and other figures. The hero is 11 ft tall, with a span of 8 ft between his hands. He is depicted holding a boomerang, 22 x 6 in (normal size in relation to the hero) in his left hand, and is wearing armbands, two girdles, and a chest ornament which is probably a row of kangaroo teeth strung on human hair twine. There is a bar across his neck, probably indicating a necklet, and seven eyes. There are six fingers on each hand and six toes on each foot. The bottoms of his huge feet, each bearing seven toes, are turned sideways, a device necessitated by the inability of the artist to show the feet facing the viewer, as he has drawn the balance of the figure.

A woman is engraved on each side of the hero, probably his two wives but possibly a wife and daughter. One wears a girdle, the other bears five punctured dots on her body. These two women are approximately life-size; unusual features are the uneven length of the arms on one and the two short arms and the legs turned sideways (in the opposite direction to those of the hero) on the other one. The upheld arms, the general posture of the smaller woman, and the boomerang held by the hero give these poorly designed human figures a certain feeling of movement.

A large basket, engraved beside the ninth mundoe from the main group, apparently belongs to one of the women. It is 2 ft 2 in long, with a loop handle, and is striped from top to bottom as though made by the twining method although it has the shape of a coiled one. It is similar to the twined basket shown in a group near Old Bobbin Head Road in Kuring-gai Chase National Park (Campbell, 1899; pl. 21, No. 4).

Above the culture hero's right hand is an irregular oval figure (now very faint) then a set of four fish and two ovals, and an almost indiscernible and indeterminate pyriform figure. Three different sets of kangaroo tracks run through the tableau. Two sets of two pairs run north-east in two lines, and four pairs run south-east in three separate lines, which is unusual. Thirty feet to the south of the main group is another mundoe of natural size pointing towards the ancestral beings. Etheridge (1904; 45) said that immediately opposite the staff station, and on a sloping surface of rock within the westerly railway fence, is a single mundoe at right angles to the long line already described, as if approaching the latter.

Technique.—Two of the ancestral beings have smoothed outlines, in which punctures are still visible in places, from 1 to 2½ in wide and up to ½ in deep. The outlines of the little woman are ¾ in wide and from ⅛ to $\frac{3}{16}$ in deep. The basket and some of the fish have a smooth groove 1½ in wide and from $\frac{3}{16}$ to ¼ in deep. The single fish, above the line of them, has conjoined punctures ¾ in wide and ⅛ in deep. The outlines of the mundoes are all smoothed (although punctures are visible in some of them), and are from 1 to 2 in wide, and from ⅛ to ¼ in deep (with some up to ½ in deep in places). The kangaroo tracks vary from deep weathered grooves, in the majority, to one pair of narrow grooves and a single one near the pair of large mundoes, only ½ in wide and ⅛ in deep. All of the other figures are faint and difficult to discern. The majority of the figures belong to the one period, but one fish, several kangaroo tracks, and the single southernmost mundoes, were added at a later period. The outlines of the deeply grooved figures have been rubbed smooth, and the latter process has been furthered by weathering agencies.

Remarks.—Etheridge (1904; 47) thought the culture hero was Daramulan. There appears no reason to doubt that he is the great All-father hero, with his two wives, characteristic of south-eastern tribal beliefs, whose many names in different tribes are given by Howitt (1904; 488–508). He is associated here with fish, and as the site lies between Berowra Creek and Cowan Creek, two deep salt-water streams, these fish were probably a local totem and the site a totemic one at which ceremonies, connected with the increase of fish and the spirits of the totem and totemites, were performed. A complicating factor is the presence of the kangaroo tracks without the animal. The tracks obviously represent a mythical kangaroo or kangaroo totem man of the Dreamtime—perhaps a kangaroo hierarchy in the mythology. The group as a whole depicts an important historical episode in the life of the ancestral beings, one enacted during the ceremonies performed at the site. Initiated men attending these historical and initiation ceremonies, or visiting the site for any other reason such as the renewal of spiritual contacts, would follow the line of mundoes, the sacred track of the hero, from north to south to the main group, as would young men when the meaning of the group was being explained to them during initiations.

This hero is remarkably similar in general outline to the Wandjina heroes painted in the caves of northern Kimberley, in Western Australia, although the arms of the Wandjina are usually held at the sides of the body, and the face is a distinctive stereotyped pattern. The large feet turned sideways, massive body and limbs, and front-view posture are characteristic of both types of heroes.

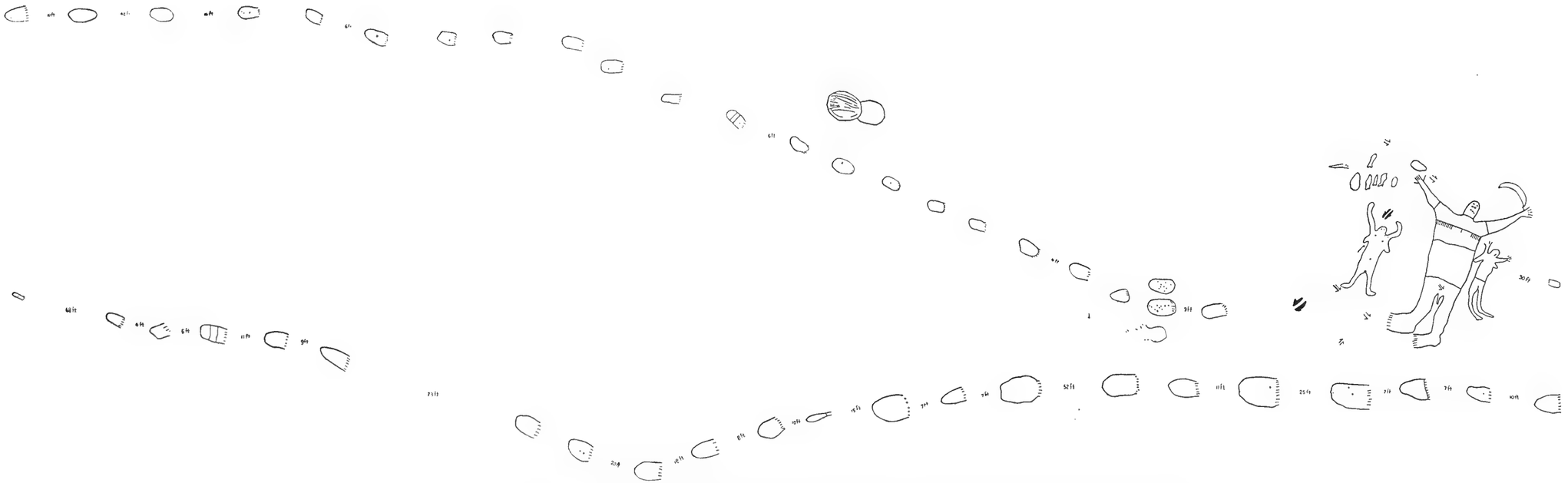


Fig. 1.—Group 1: Mt. Kuring-gai. In situ the footprints at the lower right hand corner join on to the series shown at the top left hand side of the diagram.

A preliminary recording was made of this group in 1943 by Messrs. F. L. S. Bell, H. Cocks, E. Wright and the author. It has been checked on several subsequent occasions by the author to determine obscure features of the figures.

SPRING GULLY OR COCKLE CREEK, WAITARA

[Group 2]

This group is situated at the bottom of the ridge which forms the eastern side of a tributary of Spring Gully Creek (which runs into Cowan Creek near Bobbin Head). The site is 300 yd north-east of the old Sewerage Works along the creek, and lies between a road and the creek.

Series I.—Only six figures of this group remain on portion of a large rock surface quarried away many years ago. They comprise four human foot tracks or mundoes leading to a wallaby, 4 ft long, 30 ft away, standing on both sets of limbs in a stiff pose, and a shield just over 3 ft long, with one vertical and three horizontal lines in the design. The head and fore-part of the wallaby are formed by natural cracks to which the body, tail and hind legs have been added. The outlines are of shallow conjoined punctures from $\frac{1}{2}$ to $\frac{3}{4}$ in wide (mostly $\frac{1}{2}$ in). The rough edges of the punctures in the wallaby and mundoes are indistinct and smoothed by weathering, but the shield is well preserved with a groove up to $\frac{3}{16}$ in deep. Other figures were no doubt destroyed in the quarrying.

Series II.—Situated 100 yd south of Series I, on a large rough rock surface sloping slightly towards the creek. At the southern end is (1) a shallow, curved, non-returning boomerang 2 ft long; (2) a pair of large oval mundoes 15 and 18 in long leading to (3) a maze of forty small and normal-sized mundoes (mostly oval, but one has toes) pointing at all angles; a line of twelve more mundoes leads northwards, the footmarks increasing in size as they approach (4) to (10), among which another line of four mundoes branches off eastwards; (4) skate-like fish 21 in long; (5) incomplete and indeterminate; (6) echidna, with spot on body, in profile, 2 ft long; (7) a dead echidna or the skin of one, 1 ft long, depicted in a style widely distributed in central and northern Australia; (8) stingray or skate 4 ft long with barred tail; (9) a woman 4 ft 6 in high, in an animated pose, with arms upraised, long fingers on both hands, holding an oval object like a bag in one hand with another smaller oval on one breast, and with four eyes; (10) man 6 ft 6 in high wearing rayed headdress.

A second line of nine mundoes (11) of all sizes runs from east to west from this series of figures towards (12) a man almost 6 ft high, with no head but three rays in its place, fingers on one hand, a long penis and poorly shaped legs. He is facing the main group.

Technique.—The figures were evidently done in two periods, and constitute an interesting example of technique. Among the maze of mundoes, and the boomerang, some of the outlines are of conjoined punctures but in others the punctures are from $\frac{1}{4}$ to $\frac{3}{4}$ in apart. Most of the grooves and punctures are $\frac{1}{2}$ in wide but some are only $\frac{1}{4}$ in. The majority of the punctures are circular but some are oval in shape. The mundoe with toes has a smooth groove 1 in wide and $\frac{3}{16}$ in deep. Some of the mundoes in the north-south line near the maze are also of punctures, both separate and conjoined, but they are now indistinct. The east-west series (excluding those crossing the woman's leg) are of conjoined punctures from $\frac{1}{2}$ to $\frac{3}{4}$ in wide and up to $\frac{3}{16}$ in deep. No. (12) a man, has outlines of single punctures, mostly conjoined but separated in places by up to half an inch. These punctures, $\frac{1}{4}$ in diameter, $\frac{1}{8}$ to $\frac{1}{4}$ in deep, are also circular, with flat walls and a concave bottom. This man and some of the mundoes probably belong to a later period than the other figures.

Nos. (4) to (10), the main group, and some of the large associated mundoes, have smoothed grooves mostly 1 in wide, and up to $1\frac{1}{2}$ in in some parts of the outlines, and from $\frac{1}{8}$ to $\frac{3}{16}$ in deep. There is no sign of punctures in them.

Remarks.—This group is remarkably similar in composition and layout to the one beside the Old Bobbin Head Road (Campbell, 1899; 38–39, pl. 21, figs. 4–5), 45 chs south of Bobbin Trig. Station, in Kuring-gai Chase National Park. Both groups include a man and a woman in ceremonial attire, a basket, echidna, and a line of mundoes. They thus both probably illustrate a similar mythological incident or episode. In both groups, also, a number of animals, other than the echidna, are represented.

In this group, the maze of mundoes may represent a meeting of natives (a group or just the three engraved), a dance, or a fight between the two men for the woman. A track leads away to one of the men and the woman. Their track is crossed by that of the second man who is posed to the westward of them. Thus we may have here the track of a man and woman eloping, their camping place shown by the maze of mundoes, the two large ovals represent them sleeping, the mundoe track their route to a fishing and hunting spot, and the other man, the husband, trailing them. The group could well represent spirit people connected with one of the totems illustrated. The technique indicates that figures were added to the group at different times, evidently by natives attending totemic or historical rites at the site.

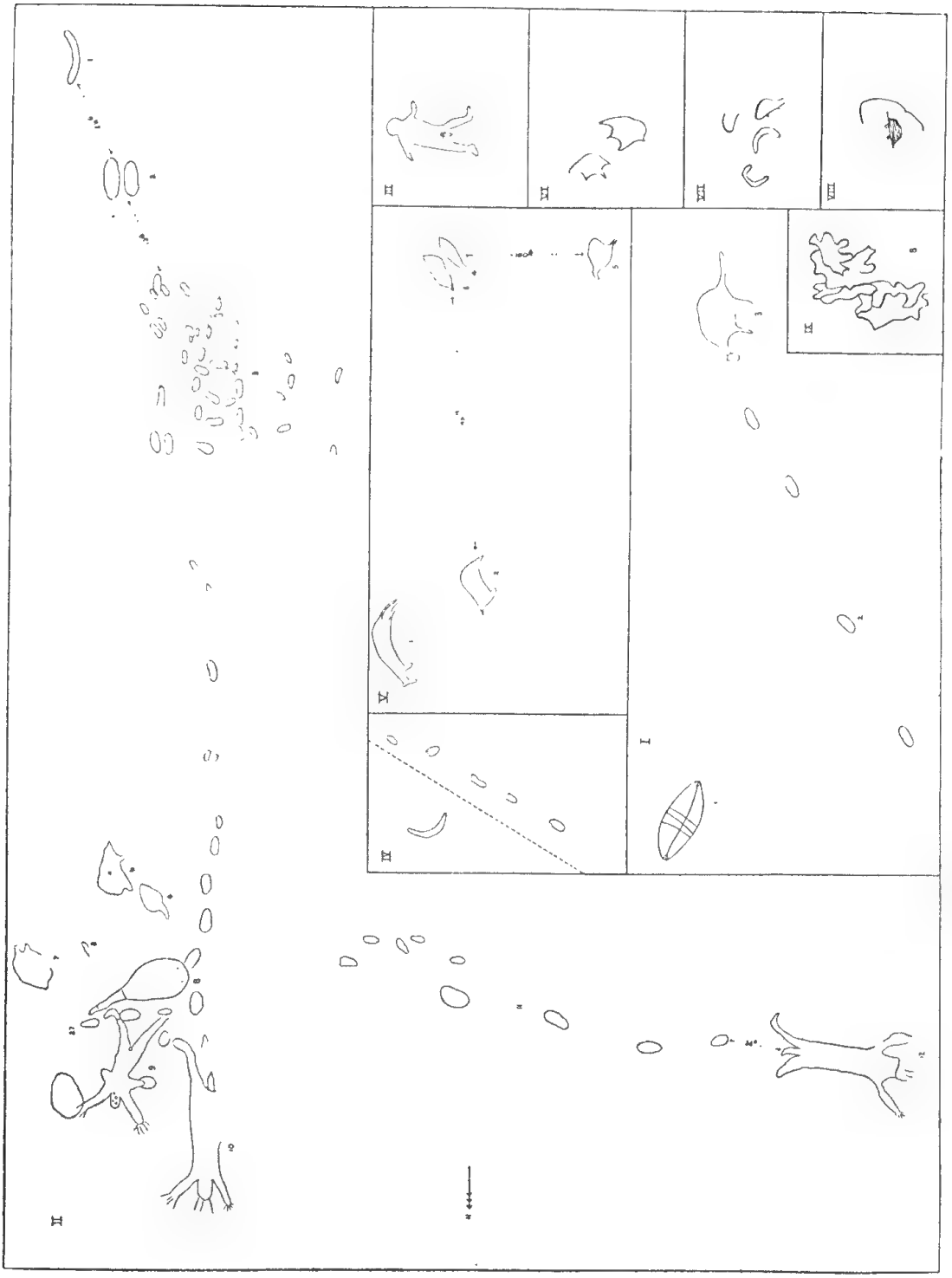


Fig. 2.—Group 2: Spring Gully or Cockle Creek, Waltara.

A similar maze of mundoes, and a track leading to various animals, is to be seen in a group in Allambie Road, Brookvale, north of Sydney.

Series III.—A poorly designed figure of a man, 3 ft 6 in high, situated 100 yd south of Series II, on the northern margin of a large rock. His outline consists of conjoined oval punctures ½ in wide, $\frac{3}{16}$ in deep, and up to 1 in long.

Series IV.—Engraved on a large sloping but flat rock 150 yd north-west of Series II. At the lower end of the rock is a boomerang, and 60 ft away at the other end is a line of five mundoes (with toes on three of them). The outlines are of fairly well preserved conjoined punctures, ½ in wide and $\frac{3}{16}$ in deep.

Series V.—Situated on another large rock surface 100 yd south-east of Series IV are five scattered figures. No. (1) is a wallaby 3 ft 3 in long and (2) an echidna 2 ft 3 in long; (3), (4), 45 ft southward are two fish, and 100 ft west of them is (5) a young emu. The outlines are of conjoined punctures ½ in wide and $\frac{3}{16}$ in deep, but that of the emu is a smooth groove 1 to 1½ in wide.

Series VI.—Two echidnas 30 ft apart, with conjoined punctured outlines. Series VI to IX are situated about a quarter of a mile north of Series I, and about the same distance from Cook Trig. Station.

Series VII.—Two boomerangs about 1 ft long, small figure probably a mammal, and indeterminate figure.

Series VIII.—A small striped bandicoot or rat inside a crescentic line.

Series IX.—One hundred feet south-west of Series VII. A line maze approximately 2 ft square.

(Recorded by the author and F. Hansen, May, 1946)

MAROOTA

[Group 3]

This group is situated in the Maroota district, but its precise location cannot be disclosed. The figures are engraved on the southern end of a spur (running east and west) above a low saddle. Creeks run down from this saddle to the north and south. The rock slopes gently from north to south and is broken here and there by patches of heath. The engravings form a U-shaped series, following the exposure of rock. There are patches of tessellations on this rock but there are no engravings among them.

The sixteen engravings are as follow:—

Nos. (1), (2), two large barred eels 5 ft long; (3) goanna or flying phalanger just over 4 ft long, with a peculiar foreleg on one side. No. (4), seventeen short straight grooves, from 1 to 2 in long, in an arrangement not recorded previously. There are pairs of these short grooves beside (5) and (7) and they have previously been noted beside an owl in the Wollombi district (McCarthy 1941, pl. G, fig. 2). Their meaning is unknown.

Nos. (5) to (7) three koala bears, from 2 ft to 4 ft 9 in long, in typical lateral pose with the forelegs represented as one long limb curved upwards in front of the face, fingers being shown on two of them. Two eyes are shown on the smallest koala, and one eye on each of the other two figures. The heads vary from a realistic one (6) to a dog-like face (7) and a pointed chin (5). No. (8), a leaping kangaroo, in classical pose, with five human footprints representing the tracks of the hunter, and a short line in the tail possibly representing a spear. Nos. (9) to (11), two pairs of kangaroo tracks, (9) pointing northwards away from the above kangaroo hunt but towards (10), an unusual portrayal of a man, just under 4 ft long and wide, with his legs up and with well marked penis. He is broad bodied and his arms are in the commonly shown upraised position. He is beside (11) a large kangaroo 8 ft 6 in long, leaping westwards in a classical pose.

Technique.—The outlines of (1) to (9) consist of conjoined punctures from ½ to ¾ in wide and up to ⅛ in deep, weathered but well preserved, and all of the same period. Those of (10) and (11), the man and large kangaroo, are 1 in wide and from ⅛ to $\frac{3}{16}$ in deep, weathered and smooth, and more heavily worked than the other outlines.

Remarks.—The main features of this group are the kangaroo hunts in (8) and (9) to (11). The grooves indicate that they either form two separate episodes, or, though they were engraved at different periods, belong to the one legend. The koala, eels, and goanna or phalanger were probably totems of the members of the local group which occupied this locality. Three koala bears have not been recorded previously in one group.

(Recorded by the author, October, 1957)

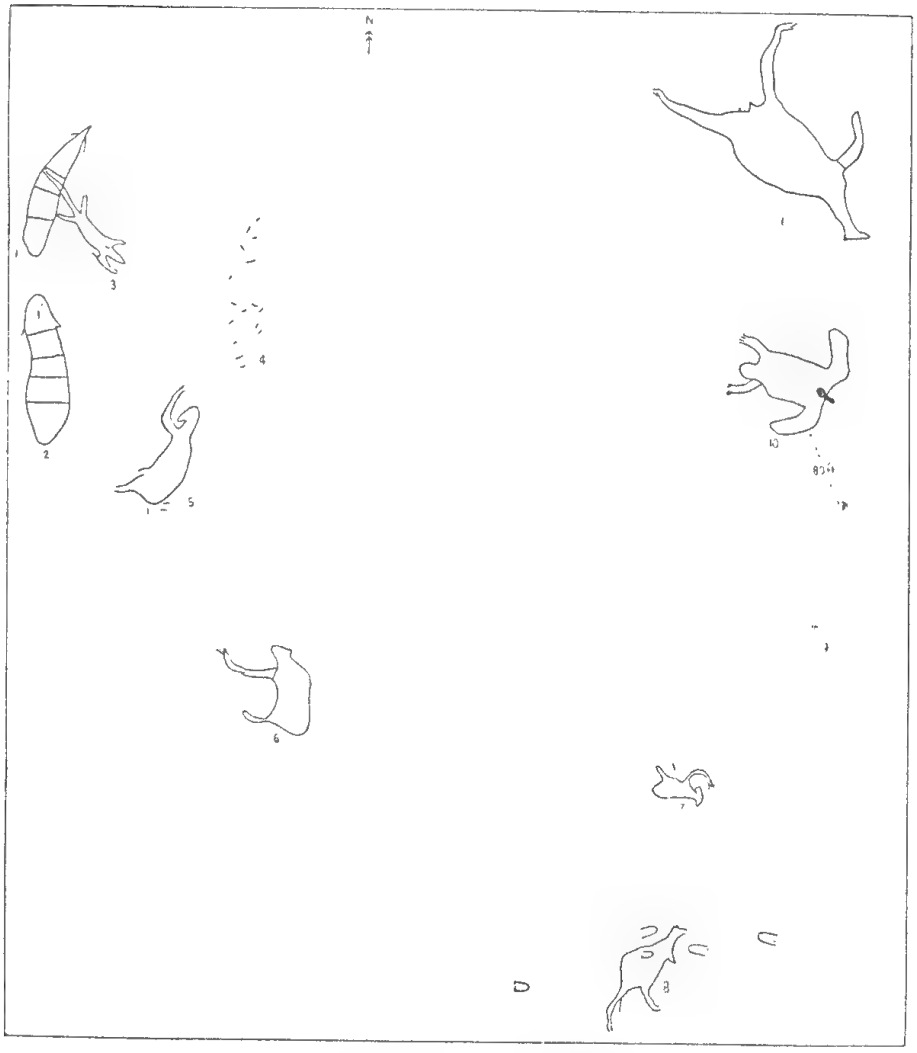


Fig. 3.—Group 3: Maroota.

OLD NORTHERN ROAD

[Group 4]

This group is situated half-a-mile to the west of the old Northern Highway at a point 3½ m from its junction with the Windsor Road opposite Beckett's Forest. The site is at the head of one of the tributaries of the southern branch of Stone Chimney Arm Creek.

Series I and II are at the eastern end of a number of large rock surfaces which extend in a crescent to the top of a ridge to the north-west, where Series III is located. There are several orchards in the vicinity and these carvings are now on Mr. F. S. Mitchell's allotment which is in the process of being cleared for cultivation.

Series I.—On a sloping but flat rock, which forms the bed of a creek on the edge of a marshy slope, are three circular potholes about 3 x 2 ft in size, and up to 2 ft deep, with almost vertical walls. Two of them hold water, and the other one is filled with soil in which heath is growing. On the lower side of them are 12, 12 and 4 axe grooves respectively. A groove of conjoined punctures is engraved behind two of the potholes, a custom noted previously at several localities in Kuring-gai Chase National Park and Terrey Hills.

Series II.—One hundred feet to the north-west of Series I is a very large expanse of sandstone, about an acre in size, in two levels. At its top end are (1) and (2). No. 1 is a puzzling creature to identify. It has a kangaroo's body—tail, leg and humped back—a fin and a wing, and a strange head which resembles that of a kangaroo wearing a headdress. Looked at from the southern or left side it is a composite figure of a kangaroo with fins (related to the whales and dolphin in the group) and a headdress, which, extended further into a ritual interpretation, would represent an ancestral

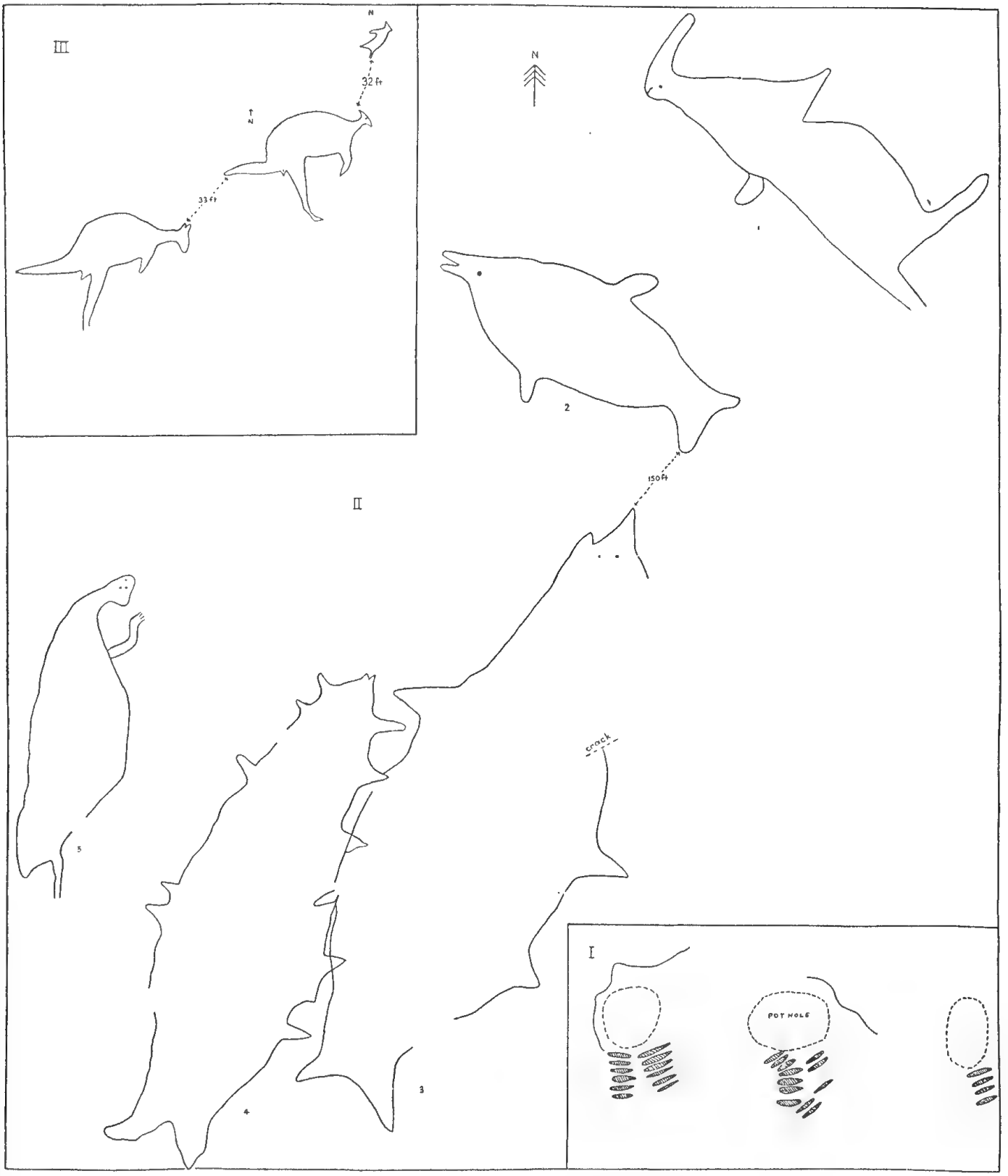


Fig. 4.—Group 4 : Old Northern Road, Maroota.

being of the one-legged Daramulan type in the guise of these two totems. However, when the figure is looked at from the northern or right side it resembles a large bird, with small wings and a long flat bill, although the mouth on the back of the head is difficult to account for if this interpretation is accepted. It is 17 ft long, with the legs incomplete, and is obviously a ritual figure. Beside it is (2) a well proportioned dolphin 15 ft long.

One hundred and fifty feet south of (1), (2), are three more large engravings. No. 3 is a whale almost 30 ft long, with portion of its outline not engraved on one side. It has four fins, open mouth and two eyes, and is reasonably well proportioned. Beside it is another whale 24 ft long with five fins on each side, evidently drawn by a man who had not seen many whales but knew they had fins. The outlines of these two whales overlap in the middle of one side.

No. (5) is another strange animal, evidently a spirit or a sacred and gigantic depiction of a koala bear. It has the typical head and front limb, with digits, shown by the artists in koala bears among the Sydney-Hawkesbury engravings, but the straight hind limb and pointed posterior are unusual characters. It is 17 ft long.

Technique.—The outlines of these five figures are all well preserved, with smooth rubbed grooves from 1 to 1½ in wide and up to ⅜ in deep.

Remarks.—This is a sacred site of considerable importance. The two gigantic spirit figures (1) and (5), of the bird or Daramulan, and of the koala bear, establish it as one visited by a sky-hero in a totemic guise at either initiation or increase rites. The dolphin is also larger than life size and is apparently a Dreamtime representation. It is surprising to find whales and a dolphin engraved at a site so far from the coast. No doubt the local natives visited the lower Hawkesbury River to join in whale feasts, and it is not known how far up the river such marine mammals travelled. These engravings could, of course, represent totems of coastal women who married into this local group at Maroota, or they may simply represent marine creatures esteemed for their enormous food supply when stranded (whales) or speared (dolphin). The engravings of whales and dolphins are the furthest west known, but there is a large swordfish engraved on Flat Rocks Ridge (McCarthy, 1956; Fig. 4, No. 27) on the other side of the Hawkesbury River. Perhaps visiting natives, with these totems, engraved the figures, but large subjects like these would take a long time and many visits to complete, too long for visitors who might be on their way to the important source of pebbles for axes in the Castlereagh area.

Series III.—On the south-western side of a large rock surface, at Mr. Mitchell's corner boundary, are engravings of two fine buck kangaroos 8 ft and 7 ft 3 in long, in classical leaping posture, and a wallaby 1 ft 9 in long, scampering away as fast as he can go. The convex pointed head of one of the kangaroos is unusual.

Technique.—The wallaby and one kangaroo have conjoined punctured outlines ½ in wide and up to ⅛ in deep; the other kangaroo has smooth grooves ¾ to 1½ in wide, and up to ¼ in deep.

Remarks.—This area was evidently a favoured hunting place for these animals which were either depicted at different times or the outlines of one were rubbed at a period subsequent to the original puncturing. It appears to be an older figure than the other two.

(Recorded by the author and J. Beeman, October, 1957)

OLD NORTHERN ROAD

[Group 5]

This group is situated on a large rounded rock of dark brown and hard ferruginous sandstone, beside the western side of the old Northern Road at a point 2½ m from its junction with the Windsor Road. The Main Roads Board of New South Wales generously diverted the old Northern Road during its reconstruction some years ago to preserve this most important group.

The figures form a semi-circular series from the south-west to the north-east, and are on the top of the rock which slopes southwards. No. (1) at the southern end, is an indeterminate elongate figure with a pointed head, four eyes in a row, one arm and one leg, with a well-marked rump. It resembles portrayals of the koala bear in the Sydney-Hawkesbury area. Beside it are Nos. (2) and (3), a boomerang and an unfinished open-ended figure. No. (4) a koala bear with a human-like breast, is shown in profile with one leg and one arm, and is reaching towards Nos. (5) and (6), two men in rayed headdresses, both wearing girdles and one bearing on his chest a line design which probably represents a painted pattern. Both have fingers on the right hand but not on the left one. Both are in a realistic attitude, posed as though participating in a dance-drama. At the northern end is (7), a huge ancestral being 14 ft 6 in long, of the Baiami type, with two huge legs but small arms, wearing a girdle and armlets, and bearing body stripes from the shoulders to the ankles. His head is not joined to his body and no penis is indicated. Although poorly proportioned, this figure suggests great strength and power from its bulk and a certain feeling of movement from the pose of the arms and head. No. (8) is an incomplete figure, of indeterminate nature, on the northern slope of the rock.

On a small isolated rock is a human foot track. On a large rock exposure, beside the edge closest to the main group, and 40 ft from it, are four indeterminate line and dotted or punctured figures (9).

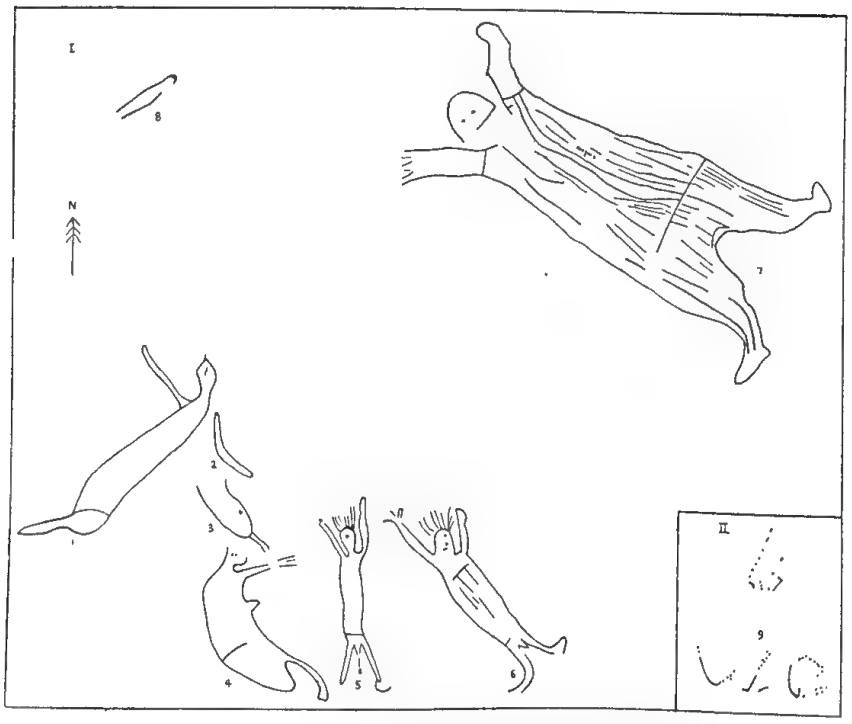


Fig. 5.—Group 5: Old Northern Road, Maroota.

Technique.—The eight figures in the main group have smooth rubbed outlines, $\frac{3}{4}$ to 1 in wide and $\frac{1}{8}$ to $\frac{3}{16}$ in deep, although large punctures are still visible in parts of the grooves. Parts of the grooves in the large hero are $\frac{1}{4}$ in deep. They are well preserved. No. (9) consists of punctures $\frac{1}{2}$ in wide and up to $\frac{3}{16}$ in deep.

Remarks.—This is a group of the most sacred type, a koala bear totem centre, with two bears and two human totemites at which the ancestral being is looking. One of the men or the hero has thrown the boomerang at the bear, and the site thus represents an incident in an historical myth. Vandals have just begun to deface this group by carving initials in the rocks.

(Recorded by the author, 1944)

DEVIL'S ROCK, MAROOTA

[Group 6]

This important group of engravings is situated on a flat-topped ridge which runs south to north from Wiseman's Ferry Road to the Hawkesbury River. The site is 100 yd from the Laughtondale Road at a point three-quarters of a mile from Wiseman's Ferry Road at North Maroota.

The rock is a large exposure, sloping from west to east, on the eastern side of the ridge. From it the view is restricted on all sides but the eastern one, which looks down the ridge through open forest and across the tops of low trees and scrub to the south. This ridge slopes down into the gorge of one of the tributaries of Laybury's Creek which flows into the Hawkesbury River several miles away.

There is a steep face 10 ft high or more on the eastern side of the rock. In the middle of the rock surface is a large patch of soil in which heath vegetation is growing, and there is a smaller patch at the north-eastern corner. It is not known whether any engravings are covered by these deposits, but it is considered unlikely.

A furlong to the north is another extensive exposure of rock, in the middle of which are three potholes 6 x 6, 10 x 10 and 25 x 20 ft in size, and from 2 to 3 ft deep, which hold water at all times except possibly after a series of drought years. Another series of rock surfaces occurs to the south on a lower ridge. There are no engravings on any of these rocks.

There are two potholes on this rock with 14 and 9 axe-grinding grooves beside them, respectively. Another large pothole, 5 ft in diameter and 2 ft 3 in deep, which was filled with soil, was dug out by a party from the Anthropological Society of New South Wales but no implements were found in it.

The forty-four figures comprise:

Nos. (1) to (4), on the western side of a car track which runs through the group, on a flat rock in the north-western corner of the outcrop. No. (1) is a bent line 6 ft long, like a spear; (2) an indeterminate tailed figure; (3) a leaping wallaby or kangaroo, just over 4 ft long; (4) a headless wallaby 2 ft long. No. (5), in the middle of the western side of the main rock, on a slight hump, is a well proportioned leaping kangaroo 9 ft 4 in long, struck by six boomerangs on the body and by a spear in the stomach. No. (6) is a fine leaping wallaby or kangaroo 5 ft 3 in long. Nos. (7) to (11) at the southern end of the group is an unusually interesting composition of an ancestral being with an emu (8) and shield (9), mundoe (7) and another figure (10). The ancestral being, 20 ft 3 in high, is wearing an eight-rayed headdress (with a bar across the top and a dot below it) and also a girdle and several necklets. His oval body is decorated with six vertical rows of oval and circular basin-shaped pits 1 to 2 in long, $\frac{3}{4}$ to 1 in wide, or 1 in in diameter, which evidently indicate a cicatrice or painted pattern on his chest and stomach. His back is demarcated by a line pattern. His small head is un-aboriginal with its long face, pointed nose and bearded mouth. One eye is shown, and the "Adam's Apple" prominence is clearly indicated on the exceptionally long and thin neck. He has one arm bearing three long fingers. His legs are very short for such a long body and one bears four toes. His erect and large penis has the shape of an uncircumcised organ, the bar across which apparently represents either a painted band or the gland inside the foreskin. Beside this great hero is a large emu 10 ft long, with a barred neck and leg, and a well marked foot to which is attached an indeterminate figure. Inside the emu is an oval shield, 3 ft long, of the well-known coastal type. There is a human foot or mundoe 5 ft away pointing towards this set.

Nos. (12) to (15) make a group of four small figures (23 ft south-east of (7)) comprising (12) a circle 2 ft in diameter, (13) a delicately posed bird, (14) three oval mundoes without toes and (15), short punctured line.

Beginning the greatest assemblage of figures in the group as a whole is a line (16) of eighty-five circular and oval pits, 1 to $1\frac{1}{2}$ in in length or diameter and $\frac{1}{4}$ in deep, which begins 80 ft north of the great ancestral being (37) and runs in a sweeping curve southward through the group for just over 100 ft to (11), another ancestral being. This is a unique kind of sacred track unrecorded elsewhere.

No. (17) a small circle; (18), (19), two narrow parrying shields 18 to 23 in long; (20), a snake-like figure 10 in long; (21) fourteen axe-grinding grooves in and beside a shallow depression which holds water during rainy periods and into which water could be tipped for grinding blades; (22) sword club; (23) a series of four complete (and one unfinished) boomerangs, from 10 in to 2 ft long. One boomerang is barred at each end. No. (24) short elliptical figure of unknown significance; (25) sword club; (26) hind portion of a large kangaroo with very weathered outlines. Part of the rock bearing the outline has spalled away.

Nos. (27) to (30): Further northward is a kangaroo hunting composition in which a man 7 ft 6 in high has thrown a boomerang at two leaping kangaroos. One is a buck 10 ft 7 in long (from nose to end of outstretched tail) with digits on the foreleg, an oval figure inside its outline, and bars on the foreleg, shoulder and tail. The other one, 5 ft 2 in long, is an earless doe or young animal.

No. (31), nine axe-grinding grooves beside a shallow pothole; (32) large pothole 5 ft in diameter and 2 ft deep. Beside it is a splendid picture of an emu just over 8 ft long, standing over a clutch of eleven eggs, with three of the bird's tracks leading away from the nest and the pothole. This is a unique composition in the Sydney-Hawkesbury district. Emus were plentiful on Emu Plains a few miles to the west. No. (33) pointed oval figure 2 ft long, probably a shield lacking the usual crossed line design shown in (8).

No. (34) a ground bird, like a scrub turkey, almost 6 ft long, with an unusually small tail, broad bifurcated leg and large eye, standing over a clutch of six eggs in a line; (35) irregular oval; (36) fish; (37) an ancestral being just under 14 ft tall, in a stiff spread-eagled pose. Fingers, toes and bars are shown on the limbs, and a girdle on the body. Four rays form part of a forehead band or headdress. Four eyes and, most unusually, two large ears, are shown on the head. Eight lines of pits in the basin technique, to indicate a cicatrice or painted design, are shown on the body, together with several small right-angled lines. The penis is decorated with a line of seven dots and a bar, evidently the pattern of a painted design.

No. (38) a peculiar oval figure with two antennae, like a slug; (39) a spear and spear-thrower in a linear style; (40) a curved elongate figure 4 ft long, of unknown significance; (41) leg of bird like an emu; (42) clutch of eight small eggs in two rows.

Technique.—As in most of the extensive galleries of engravings the technique indicates that figures were made at this site over a long period.

Nos. (1) to (4), (40), (41) have a conjoined punctured outline $\frac{1}{2}$ to $\frac{3}{4}$ in wide and up to $\frac{1}{8}$ in deep. Nos. (12) to (15), (17) to (19), (22) to (25), (30), (33), (35), (36), (38), (39) have a very faded outline $\frac{1}{2}$ to 1 in wide, $\frac{1}{16}$ in deep, smoothed by weathering, and many of these are so faint that they can only be seen in a morning or afternoon side-light. Nos. (5) to (11), (27) to (29), (32), (34), (37) have a smooth rubbed outline, from 1 to $1\frac{1}{2}$ in wide and $\frac{1}{8}$ to $\frac{3}{16}$ in deep, in which punctures are partly visible in some places. No. (20) has an unusually big 2 in wide and $\frac{1}{2}$ in deep groove with straight walls.

Remarks.—This is undoubtedly one of the finest and most important groups of engravings in the Sydney-Hawkesbury district. Artistically, it is a planned composition from north to south, or vice

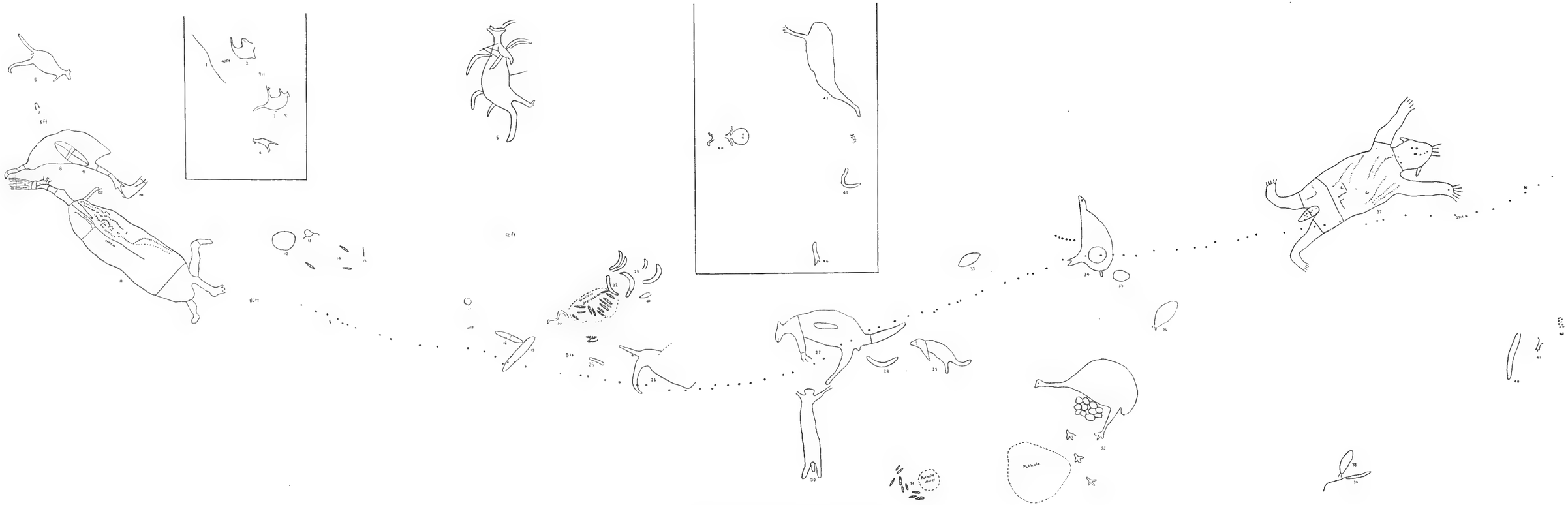


Fig. 6.—Group 6: Devil's Rock, Maroota.

versa, with a few extraneous figures to the west and east of the main series. The two magnificent ancestral beings are linked together by the long line of pits, along which are shown a nesting emu and ground bird, a kangaroo hunt, a series of weapons (boomerangs, shield, sword clubs) and a fish. Here we have the layout of portion of a Bora initiation ground, where the novitiates are told the tribal beliefs when being shown the figures, symbols of the tribal religion. Historical ceremonies were performed here and, if representations of nesting birds are any indication, totemic increase rites were also enacted.

The ancestral being in (37) is identical with the figure of the great All-Father hero, Baiami, of south-eastern Australian tribes, described in many papers by Mathews (1905) and by Howitt (1904) and illustrated in Kerry's photographs, as being made by shaping soil and sand over a framework of logs on the Bora grounds west of the Great Dividing Range and on the south and north coasts of New South Wales. The other hero, (11), probably represents Daramulan (the son or brother of Baiami), with his shield and with his totem the emu. The presence of both heroes in the one group demonstrates its immense importance in the rituals of the tribes.

This group is similar in composition to the Flat Rocks ridge groups (McCarthy, 1956; fig. 5, group 6) on the other side of the Hawkesbury River, about 10 m to the north of Maroota. Both include two ancestral beings of comparable types, kangaroo hunts, and emus in a group or nesting. They illustrate, in these themes or motifs, some of the most fundamental inspirations yet revealed among the engravings of the Sydney-Hawkesbury district. In another group (McCarthy, op. cit. fig. 3, group 2) on this ridge a huge mythical kangaroo struck by twelve boomerangs resembles very closely (4) in the Devil's Rock group at Maroota. Other figures of various kinds occur in one or both of these groups.

Series II.—A furlong south-west of Series I, on a flat rock, are four scattered figures, as follows: (43), an emu 8 ft long in an alert suspicious pose; (44) unique human figure, 3 ft 7 in high, with a very large head, two eyes, and a slender body; (45) thirty-five feet east of (44) is a returning boomerang 10 in long; (46) indeterminate figure with bifurcated end, like a narrow bag or basket, 1 ft long. The weathered outlines are 1 in wide and $\frac{1}{8}$ in deep.

Recorded by Misses E. Bramell and G. Bell, Professor A. P. Elkin, Messrs. F. L. S. Bell, J. H. Cocks and E. H. Wright, and the author, 1943, and subsequently checked on several occasions by the author.

This group is a reserve on the boundary of Mr. J. Trevenna's orchard. He does his utmost to protect the figures, but the site is well-known and is visited frequently by people interested or otherwise in the rock art of the aborigines. Fortunately, it has not yet been defaced.

UPPER CRESCENT REACH, CATTAI

[Group 7]

This group is situated at the end of a ridge two miles long around which flows Upper Crescent Reach of the Hawkesbury River. The last half mile of the ridge is rocky, but lightly forested. The rock bearing the engravings is about half an acre in extent, sloping slightly from west to east, and outcrops on the western side of the ridge, about a furlong from the river. On the eastern side there are extensive swamps and lagoons (and citrus orchards) frequented by swans, ducks, ibises and other birds: they begin 100 yd from the site. From this rock is to be seen an extensive view (probably somewhat restricted by trees in pre-white man days) across to the opposite side of the river. The site is now on a farm (Mr. Payn's), the military map reading being 900.587.

The site was first reported by Mathews (1901; pl. ix, fig. 1), and subsequently republished by the same author (1910; 403, fig. 1), but he said nothing about the outlines of the figures or the axe grooves and his drawing is inaccurate. There is no vertical stripe on the nose, and the tail is slightly different to that shown in his figure. The eyes are now practically indiscernible.

The gigantic figure engraved here is 37 ft around the curve of the body, from nose to tail, and 29 ft across the curve. Its greatest width is 6 ft. The ears are well marked, there are two bands (curved) across the nose, one band across the neck, and two across both the body and the tail. The significance of these bands is unknown.

A few feet away from the tail-end of this figure are two pairs of kangaroo or wallaby tracks, not shown by Mathews.

On the eastern side of the big figure, and on the eastern slope of the rock, are five potholes, up to 1 ft deep, and from 10 to 25 ft apart, around which there are in all 138 axe-grinding grooves (4, 6, 33, 39, 55 and an odd 1). Beside two of the potholes, from four to six of the grooves are arranged in unusually neat rows.

Technique.—The outline of the main figure is from $1\frac{1}{2}$ to 2 in wide, and from $\frac{1}{8}$ to $\frac{1}{4}$ in deep, with smooth sides. There are no punctures visible, these having been eliminated in the deepening and widening of the original groove by abrasion. The kangaroo tracks are also smoothed, with grooves 1 in wide and $\frac{1}{8}$ in deep.

Remarks.—The remarkable main figure at this site is identical with three others depicted being speared by men in the Peter Howe Sanctuary (McCarthy, 1947; 322–29, pl.AD), two in another group (unpublished) at Somersby, and one on the Flat Rocks ridge, Gunderman (McCarthy, 1956; 51, fig. 10,

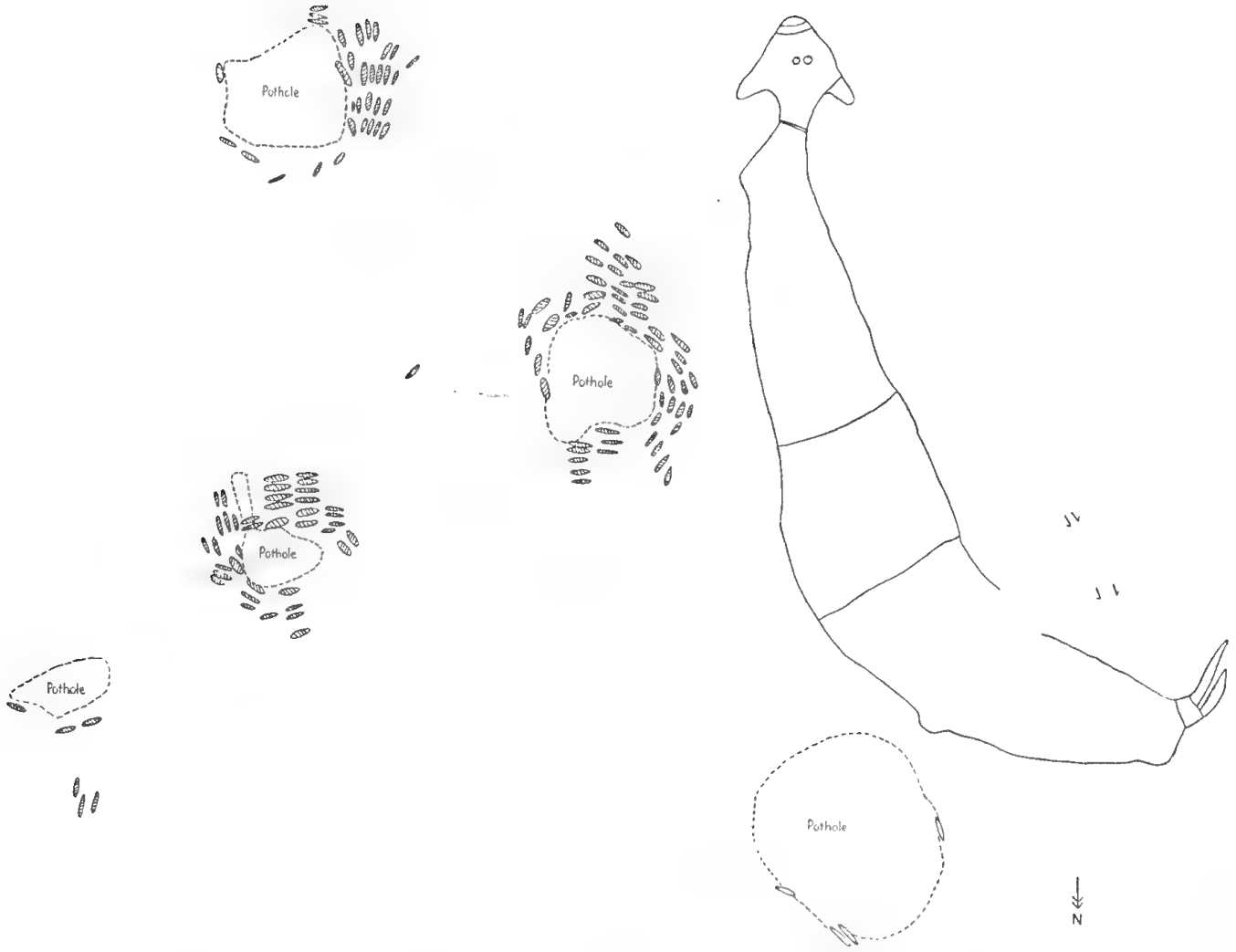


Fig. 7.—Group 7: Upper Crescent Reach, Cattai.

No. 6). These are all big figures, from 10 to 35 ft long, on the northern side of the Hawkesbury River, and from twelve to twenty miles away, in a direct line, from Upper Crescent Reach. I regard them as being Rainbow-Serpents, and discussed the evidence fully (1947). Generally speaking (Radcliffe-Brown, 1926 and 1930), the Rainbow-Serpent belief is characteristic of Australian aboriginal religion as a whole, and is a feature of the Bora initiation ceremonies of south-eastern Australia. The Rainbow-Serpent represents the element of water and is visible as the rainbow, thus being integrally identified with rain and rain-making. It lives in a waterhole, lagoon or river, or is associated with waterfalls in which rainbows are seen. It is the source of magical powers, and of the quartz and other crystals, of the medicine-men and sorcerers who alone may approach its abode with safety, other people doing so being killed and eaten. It is, as Radcliffe-Brown said, a deity, the object of a definite totemic cult or of a cult forming part of the initiation ceremonies. Representations of it, up to 4 ft long, were prepared and painted in these ceremonies. It was called Gurunaty or Gurunatch by the Gundungurra tribe of the Blue Mountains and Camden districts (Mathews, 1905; 143), and by other names by the different tribes in whose beliefs it figured. It probably was thought to have lived in the river at Upper Crescent Reach, and in swamps near the site, and, as was usual when a Rainbow-Serpent was believed to live in a river, it probably would have been considered responsible for carving out the channel of the river (in this instance, of the Hawkesbury River).

In the various groups described in this paper are included large figures of both the Daramulan and Baiami types of ancestral beings or heroes, and also of the Rainbow-Serpent. These are among the most important deities in the religious complex of south-eastern Australian tribes, and the importance of these groups, and of this area from a ritual point of view, cannot be over-emphasized. The full implications of these figures will be discussed in a monograph on the rock engravings of the Sydney-Hawkesbury district now in preparation.

(Recorded by the author, February, 1958)

1

2

3

4

1

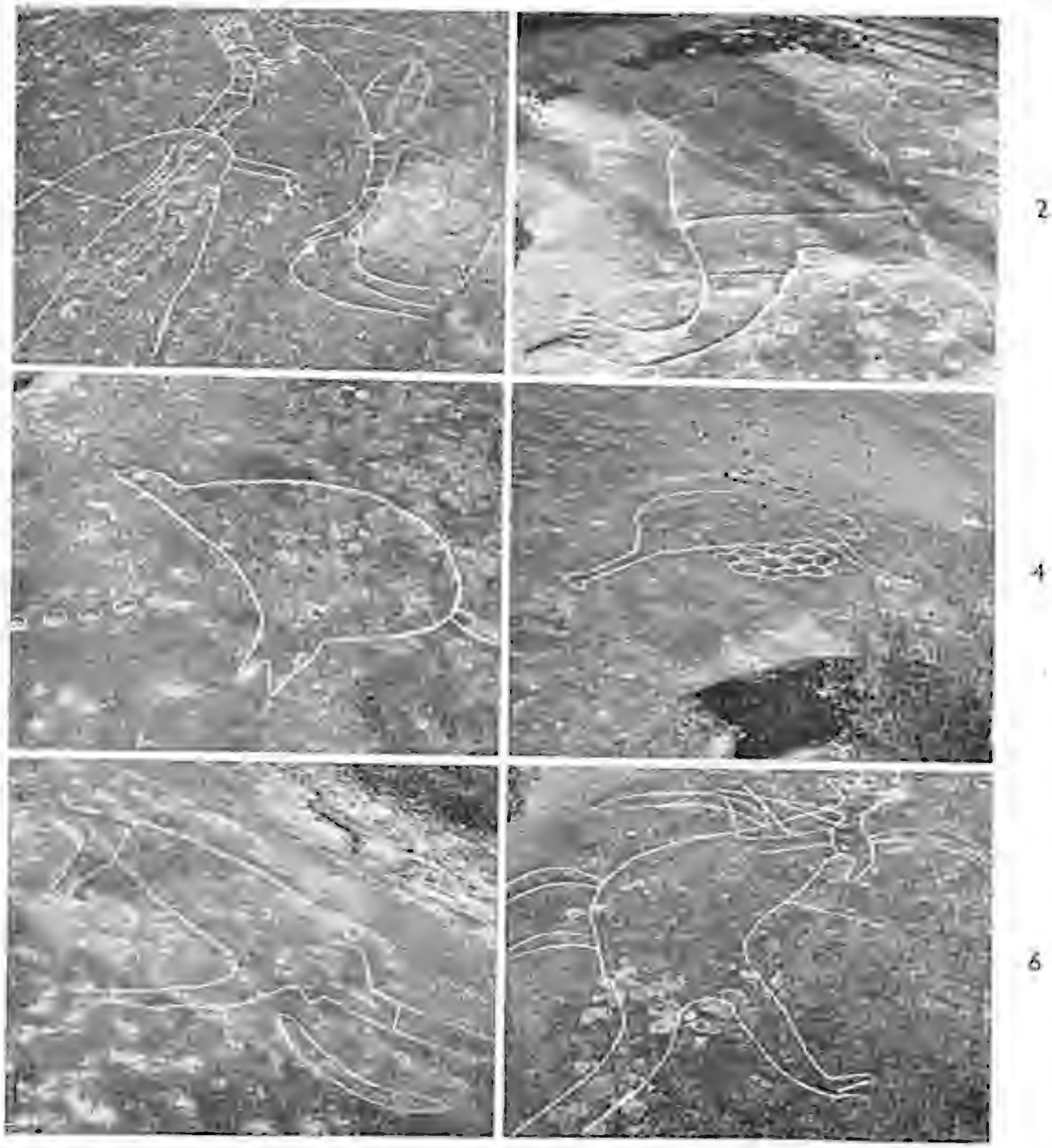
2

3

4

5

6


1
2
3
4
5
6

References

Brown, A. Radcliffe-, 1926. The Rainbow-Serpent Myth in Australia. *J. Roy. Anthrop. Inst. Gt. Brit. Irel.*, 56 : 19–25 pl. 1.

————————, 1930. The Rainbow-Serpent Myth in South-eastern Australia. *Oceania*, 1 : 342–47.

Campbell, W. D. 1899. Aboriginal Carvings of Port Jackson and Broken Bay. *Mem. Geol. Surv. N.S.W.*, Eth. Ser., 1.

Etheridge, jun., R. E. 1904. Aboriginal Petroglyphs between Beaumont and Hamley Trigonometrical Stations, Kuringai. *Rec. Aust. Mus.* 5 : 118–21, pls. xii-xiii.

Howitt, A. W. 1904. The Native Tribes of South-east Australia. MacMillan, London.

McCarthy, F. D. Records of the Rock Engravings of the Sydney District. Nos. 1–7. *Mankind*, 3, 1941 : 42–56, pls. I–M; Nos. 8–20, op. cit. 3, 1944 : 161–71, figs. 1–11; Nos. 21–32, op. cit. 3, 1945 : 266–74, pls. T–U; Nos. 33–37. op. cit., 3, 1946 : 266–72, pls. Z–ZZ; No. 38, op. cit. 3, 1947 : 322–29, pl. AD; Nos. 39–40, op. cit. 4, 1949 : 61–67 pls. C–E; Nos. 41–55, op. cit. 5 : 5–32, figs. 1–11, pls. A–C; Nos. 56–71, op. cit. 5, 200–08, figs. 1–12.

————————, 1956. Rock Engravings of the Sydney-Hawkesbury District. Pt. 1. Flat Rocks Ridge : a Daruk Ceremonial Ground. *Rec. Aust. Mus.* 24 (5) : 37–58, figs. 1–14, pls. 3–6.

Mathews, R. H. 1901. Pictorial Art among the Australian Aborigines. *J. Tr. Vict. Inst. Lond.* 33 : 291–310.

————————, 1908. Some Mythology of the Gundungurra Tribe, New South Wales. *Zeit. f. Ethnol.* 40 : 203–06.

————————, 1910. Some Rock Engravings of the Aborigines of New South Wales. *J. Roy. Soc. N.S.W.*, 44 : 401–5, figs. 1–7.

Explanations of Plates

Plate 23.

1. Mt. Kuring-gai (Group 1). Ancestral being, with boomerang in left hand, wearing armlets, girdle and chest ornament.
2. Upper Crescent Reach (Group 7). Serpent and potholes.
3. Mt. Kuring-gai (Group 1). The ancestral being and one of his two wives. The other wife is between his outline and the first small island of vegetation (right).
4. Mt. Kuring-gai (Group 1). Pair of large human feet or mundoes.

Plate 24.

1. Upper Crescent Reach (Group 7). Head of serpent. The eyes are very faint but one (unchalked) is visible near the middle of the head.
2. Upper Crescent Reach (Group 7). A pothole surrounded by axe-grinding grooves.
3. Maroota (Group 3). Two koala bears, phalanger and two eels (a steel tape datum line crosses the figures).
4. Maroota (Group 3). Kangaroo hunt.
5. Old Northern Road (Group 4). Leaping kangaroo (unchalked).
6. Maroota (Group 3). Koala bear.

Plate 25.

1. Mt. Kuring-gai (Group 1). Basket.
2. Old Northern Road (Group 4). Upper part of composite spirit creature.
3. Old Northern Road (Group 5). Two men in ceremonial attire.
4. Old Northern Road (Group 4). Pair of whales in foreground, with general view of site. The dolphin and composite spirit creature are engraved on the rock behind the line of trees, in the middle.
5. Old Northern Road (Group 5). Two men, koala bear, boomerang, and indeterminate animal, probably another koala bear.
6. Old Northern Road (Group 5). Ancestral being.

Plate 26. Devil's Rock, Maroota (Group 6).

1. Ancestral being, with emu and shield, at southern end of group.
2. Ancestral being at northern end of group. Portion of the line of pits is shown on the right.
3. Bird and eggs. There is a circle (unchalked) on the body of the bird.
4. Emu, eggs and tracks beside a pothole.
5. Boomerang thrown at one of a pair of fleeing kangaroos.
6. Kangaroos struck with a number of boomerangs and a spear.

Sydney: V. C. N. Blight, Government Printer—1959

INDEX

Sydney: V. C. N. Blight, Government Printer—1959